Table of Contents

		Page	
1.	Tests	vi	1/A9
2.	Material Test Index	viii	1/A11
3.	Application Index	xii	1/B5
4.	Introduction	1	1/B8
5.	Discussion of Test Methods		
	I. Thermochemical Tests	2	1/B9
	II. Physical Property Tests	8	1/C1
	III. Qualification Criteria for Viking Materials	10	1/C3
6.	Data Section		

Material	Manufacturer		
Ablefilm 501-1	Ablestik Labs	15	1/C8
Ablefilm 535-1	Ablestik Labs	18	1/C11
ADX-41	Hysol	20	1/C13
Armstrong A2/ACT E	Armstrong	23	1/D2
Bacon FA13/BA-39	Bacon Industries	26	1/D6
BC-328A/BC-328C	Dolph	29	1/D9
BLH-EPY 500	Baldwin-Lima-Hamilton	32	1/D12
Bondmaster E645	National Starch and Chemical Corporation	35	1/E1
C7-4248	Hysol	38	1/E4
CMC-15 Bonding Film	Circuit Material Co.	41	1/E7
Coating G2735 on Electromagnetic Core	Magnetics Corp.	44	1/E10
Coating S8993-SQ$_2$ on Electromagnetic Core	Magnetics Corp.	46	1/E12
Conductive Epoxy 5504A	E. I. DuPont	48	1/E14
Conductive Epoxy 8294	E. I. DuPont	51	1/F3
E-300 Insulating Film	Dyna-Therm Corp.	54	1/F6
EA901/B3	E. V. Roberts	57	1/F9
EA956	Hysol	60	1/F12
EA9320	Hysol	62	1/F14
EA9414	Hysol	65	1/G3
Eccobond 56C/Cat 11	Emerson and Cuming, Inc.	68	1/G6
Eccocoat EP-3	Emerson and Cuming, Inc.	71	1/G9
Eccoseal 1207/20	Emerson and Cuming, Inc.	74	1/G12
Eccostock R-25	Emerson and Cuming, Inc.	77	2/A4
ECF-550	Epoxy Coating Co.	80	2/A7

		Page	
EG818T	Mica Corp.	83	2/A10
Epocast 203	Furane Plastics, Inc. . . .	86	2/A13
Epon 815/A	Ceilcote/Eastman.	89	2/B2
Epon 828/Cat 2/Flex 871	Shell Chemical Co.	91	2/B4
Epon 828/MPDA/120 Fiberglass Cloth	Shell Chemical Co.	94	2/B7
Epon 828/Versamid 125	Shell Chemical Co.	97	2/B10
Epon 929/B	Hysol	100	2/B12
Epo-Tek H43	Epoxy Technology, Inc. . .	102	2/C1
Epo-Tek H72	Epoxy Technology, Inc. . .	105	2/C4
Epo-Tek 417	Epoxy Technology, Inc. . .	108	2/C7
Epo-Tek 417	Epoxy Technology, Inc. . .	111	2/C10
Epoxy 450 Tubing	3M Co.	114	2/C13
ES-222	Polyscientific.	117	2/D2
FM-40	American Cyanamic Co. . . .	120	2/D5
FM-96 Supported Film	American Cyanamid Co. . . .	123	2/D8
High Temp 221	High Temp Resins.	127	2/D12
HT435 Film Adhesive	American Cyanamid Co. . . .	130	2/E1
Hysol AS-7-4315	Hysol	133	2/E4
Hysol C9-4183/H2-3561	Hysol	136	2/E7
Hysol R9/H2	Hysol	139	2/E10
Impregnant 3-BA-4	Bacon Industries.	142	2/E13
Ink, Cat-L-Ink 50-100, -Cat. 20	Wornow Process Paint. . . .	145	2/F2
Ink, Cat-L-Ink 50-300-9	Wornow Process Paint. . . .	148	2/F5
Ink, Cat-L-Ink 50-407-9	Wornow Process Paint. . . .	151	2/F8
Ink, M-9-N/Cat A	Wornow Process Paint. . . .	154	2/F11
Ink, Markem 7224	Markem Corp.	157	2/F14
Ink, M-O-N, Black	Wornow Process Paint. . . .	160	2/G3
Ink, Red, 50-507-9	Wornow Process Paint. . . .	163	2/G6
Ink, Yellow, 50-202-9	Wornow Process Paint. . . .	166	2/G9
Laminate, Epoxy/Glass 102-21	Mica Corp.	169	2/G12
Laminate, Mil-P-13949 FL-GFN	Fortin.	172	3/A4
Laminate, E-787	U.S. Polymeric, Inc. . . .	174	3/A6
Laminate, G-10 FR Clad	Norplex	176	3/A8
Laminate, G-10 FR Unclad	Norplex	179	3/A11
Laminate, L-P-509 GR G-11	Formica Corp.	182	3/A14
LCA-4V/BA-5	Bacon Industries.	184	3/B2
Lefkoweld 46LM 52	Leffingwell	187	3/B5
MF500F-124 Microwave Absorber	Emerson and Cuming, Inc. .	190	3/B8
Paint, Cat-A-Lac 473-3-1/x304	Finch Paint	193	3/B11
Paint, Brolite Gloss Black Enamel	Andrew Brown.	195	3/B13

		Page	
Paint, Brolite Gloss White Enamel	Andrew Brown	198	3/C2
Paint, Nextel 401-C10	3M Co.	201	3/C5
Scotchcast 241	3M Co.	204	3/C8
Scotchcast 583 Tape	3M Co.	207	3/C11
Skyspar A423/66	Andrew Brown	209	3/C13
SMRD 100F-90	General Electric	212	3/D2
Stycast 36D	Emerson and Cuming, Inc.	215	3/D5
Stycast 1263/Cat. 31	Emerson and Cuming, Inc.	218	3/D8
Stycast 2651/Cat. 9	Emerson and Cuming, Inc.	221	3/D11
Stycast 2651/Cat. 11	Emerson and Cuming, Inc.	224	3/D14
Torr Seal A/B	Varian Associates	227	3/E3
Trucast 111M/901	Fenwal, Inc.	230	3/E6
Trucast 111M/902	Fenwal, Inc.	233	3/E9

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Nonmetallic Materials Handbook

Volume 1 - Epoxy Materials

Stanley E. Podlaseck

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Volume 1 - Epoxy Materials

Stanley E. Podlaseck
Littleton, Colorado

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under Contract NAS1-15133

National Aeronautics
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**Scientific and Technical
Information Office**

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Table of Contents

Page

1. Tests vi

2. Material Test Index viii

3. Application Index xii

4. Introduction 1

5. Discussion of Test Methods

I. Thermochemical Tests 2
II. Physical Property Tests 8
III. Qualification Criteria for Viking Materials. . . . 10

6. Data Section

Material	Manufacturer	
Ablefilm 501-1	Ablestik Labs	15
Ablefilm 535-1	Ablestik Labs	18
ADX-41	Hysol	20
Armstrong A2/ACT E	Armstrong	23
Bacon FA13/BA-39	Bacon Industries.	26
BC-328A/BC-328C	Dolph	29
BLH-EPY 500	Baldwin-Lima-Hamilton . . .	32
Bondmaster E645	National Starch and Chemical Corporation.	35
C7-4248	Hysol	38
CMC-15 Bonding Film	Circuit Material Co. . . .	41
Coating G2735 on Electromagnetic Core	Magnetics Corp.	44
Coating S8993-8Q_2 on Electromagnetic Core	Magnetics Corp.	46
Conductive Epoxy 5504A	E. I. DuPont.	48
Conductive Epoxy 8294	E. I. DuPont.	51
E-300 Insulating Film	Dyna-Therm Corp..	54
EA901/B3	E. V. Roberts	57
EA956	Hysol	60
EA9320	Hysol	62
EA9414	Hysol	65
Eccobond 56C/Cat 11	Emerson and Cuming, Inc.. .	68
Eccocoat EP-3	Emerson and Cuming, Inc.. .	71
Eccoseal 1207/20	Emerson and Cuming, Inc.. .	74
Eccostock R-25	Emerson and Cuming, Inc.. .	77
ECF-550	Epoxy Coating Co.	80

		Page
EG818T	Mica Corp.	83
Epocast 203	Furane Plastics, Inc.	86
Epon 815/A	Ceilcote/Eastman.	89
Epon 828/Cat 2/Flex 871	Shell Chemical Co.	91
Epon 828/MPDA/120 Fiberglass Cloth	Shell Chemical Co.	94
Epon 828/Versamid 125	Shell Chemical Co.	97
Epon 929/B	Hysol	100
Epo-Tek H43	Epoxy Technology, Inc. . .	102
Epo-Tek H72	Epoxy Technology, Inc. . .	105
Epo-Tek 417	Epoxy Technology, Inc. . .	108
Epo-Tek 417	Epoxy Technology, Inc. . .	111
Epoxy 450 Tubing	3M Co.	114
ES-222	Polyscientific.	117
FM-40	American Cyanamic Co. . . .	120
FM-96 Supported Film	American Cyanamid Co. . . .	123
High Temp 221	High Temp Resins.	127
HT435 Film Adhesive	American Cyanamid Co. . . .	130
Hysol AS-7-4315	Hysol	133
Hysol C9-4183/H2-3561	Hysol	136
Hysol R9/H2	Hysol	139
Impregnant 3-BA-4	Bacon Industries.	142
Ink, Cat-L-Ink 50-100, -Cat. 20	Wornow Process Paint. . . .	145
Ink, Cat-L-Ink 50-300-9	Wornow Process Paint. . . .	148
Ink, Cat-L-Ink 50-407-9	Wornow Process Paint. . . .	151
Ink, M-9-N/Cat A	Wornow Process Paint. . . .	154
Ink, Markem 7224	Markem Corp.	157
Ink, M-O-N, Black	Wornow Process Paint. . . .	160
Ink, Red, 50-507-9	Wornow Process Paint. . . .	163
Ink, Yellow, 50-202-9	Wornow Process Paint. . . .	166
Laminate, Epoxy/Glass 102-21	Mica Corp.	169
Laminate, Mil-P-13949 FL-GFN	Fortin.	172
Laminate, E-787	U.S. Polymeric, Inc. . . .	174
Laminate, G-10 FR Clad	Norplex	176
Laminate, G-10 FR Unclad	Norplex	179
Laminate, L-P-509 GR G-11	Formica Corp.	182
LCA-4V/BA-5	Bacon Industries.	184
Lefkoweld 46LM 52	Leffingwell	187
MF500F-124 Microwave Absorber	Emerson and Cuming, Inc. .	190
Paint, Cat-A-Lac 473-3-1/x304	Finch Paint	193
Paint, Brolite Gloss Black Enamel	Andrew Brown.	195

		Page
Paint, Brolite Gloss White Enamel	Andrew Brown	198
Paint, Nextel 401-C10	3M Co.	201
Scotchcast 241	3M Co.	204
Scotchcast 583 Tape	3M Co.	207
Skyspar A423/66	Andrew Brown	209
SMRD 100F-90	General Electric	212
Stycast 36D	Emerson and Cuming, Inc.	215
Stycast 1263/Cat. 31	Emerson and Cuming, Inc.	218
Stycast 2651/Cat. 9	Emerson and Cuming, Inc.	221
Stycast 2651/Cat. 11	Emerson and Cuming, Inc.	224
Torr Seal A/B	Varian Associates	227
Trucast 111M/901	Fenwal, Inc.	230
Trucast 111M/902	Fenwal, Inc.	233

TESTS

1.	Vacuum TGA	V70/23P
2.	Mass spectra of volatiles	V70/23P
3.	Nitrogen TGA	V70/23P
4.	DTA	V70/23P
5.	Isothermal weight loss in nitrogen	V70/22P
6.	Vacuum condensables	V70/22P
7.	Corona resistance	ASTM D1868
8.	Dielectric strength	ASTM D149
9.	Dielectric constant	ASTM D150; ASTM 1673
10.	Dissipation factor	ASTM D150
11.	Insulation resistance	ASTM D257
12.	Surface and volume resistivity	ASTM D257
13.	Adhesion	FTMS 141 Method 6304.1
14.	Bearing strength	FTMS 406 Method 1051
15.	Bend test	FTMS 141 Method 6304.1
16.	Compression set	ASTM D395
17.	Compression strength	ASTM D695; ASTM 1621; ASTM C165
18.	Creep	ASTM D674
19.	Dimensional stability	ASTM C548; ASTM C356
20.	Emissivity and absorptivity	V71/96P; V71/97P
21.	Flexibility	FTMS 141 Method 6221
22.	Flexure	ASTM D790
23.	Hardness	FTMS 601 Method 3021 ASTM D785 and D2240
24.	Lap Shear	ASTM D1002
25.	Moisture resistance	ASTM D570
26.	Peel	ASTM D1876
27.	Knot breaking strength	(MMC) STM F420
28.	Scratch	FTMS 141 Method 6304.1
29.	Solvent resistance	ASTM D471
30.	Specific gravity	ASTM D792

Tests (Cont'd)

31.	Tear	ASMT D624
32.	Tensile	ASTM D412; ASTM D638 FTMS 191 Method 4102
33.	Thermal conductivity	ASTM C177
34.	Thermal expansion	ASTM D696
35.	Water absorption	FTMS 406 Method 7031

Material Test Index

NAME	TESTS PERFORMED*																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Ablefilm 501-1	X	X			X																			X											
Ablefilm 535-1	X	X																																	
ADX-41	X	X																																	
Armstrong A2/Act E	X	X																																	
Bacon FA13/BA-39	X	X																																	
BC-328A/BC-328C	X	X																																	
BLH-EPY 500	X	X																																	
Bondmaster E645	X	X																																	
C7-4248	X	X			X	X																													
CMC-15 Bonding Film	X	X																																	
Coating G2735 on Electromagnetic core	X	X																																	
Coating S8993-8Q2 on Electromagnetic core	X	X																																	
Conductive Epoxy 5504A	X	X																																	
Conductive Epoxy 8294	X	X																																	
E300 Insulating Film	X	X																																	
EA901/B3	X	X																																	
EA956	X	X																																	
EA9320	X	X																																	
EA9414	X	X																																	
Eccobond 56C/Cat. 11	X	X																																	
Eccocoat EP-3	X	X																																	
Eccoseal 1207/20	X	X																																	
Eccostock R-25	X	X																																	
ECF-550	X	X																																	
EG818T	X	X																																	
Epocast 203	X	X			X																														

*Numbers refer to tests listed on pp. iv and v.

Material Test Index

NAME	TESTS PERFORMED*																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Epon 815/A	X	X																																	
Epon 828/Cat. 2/Flex 871	X	X																																	
Epon 828/MPDA/120 Fiberglass Cloth	X	X																																	
Epon 828/Versamid 125	X	X																																	
Epon 929	X	X																																	
Epotek H43	X	X																																	
Epotek H72	X	X																																	
Epotek 417	X	X																																	
Epoxy 450 Tubing	X	X																																	
ES-222	X	X																																	
FM-40	X	X			X																														
FM-96 Supported Film	X	X																							X										
High Temp 221	X	X																																	
HT435 Film Adhesive	X	X																																	
Hysol AS-7-4315	X	X																																	
Hysol C9-4183/H2/3561	X	X																																	
Hysol R9/H2	X	X																																	
Impregnant 3-BA-4	X	X																																	
Ink Cat-L-Ink 50-100-Cat. 20	X	X																																	
Ink Cat-L-Ink 50-300-9	X	X																																	
Ink Cat-L-Ink 50-407-9	X	X																																	
Ink, M-9-N/Cat. A	X	X																																	
Ink, Markem 7224	X	X																																	
Ink, M-O-N, Black	X	X																																	
Ink, Red, 50-507-9	X	X																																	
Ink, Yellow, 50-202-9	X	X																																	

*Numbers refer to tests listed on pp. iv and v.

X

Material Test Index

NAME	TESTS PERFORMED*																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Laminate, Epoxy/Glass 102-21	X	X																																	
Laminate, Mil-P-13949 FL-GFN	X	X																																	
Laminate, E-787	X	X																																	
Laminate, G-10 FR Clad	X	X																																	
Laminate, G-10 FR Unclad	X	X																																	
Laminate, L-P-509, GR G-11	X	X																																	
LCA-4V-BA-5	X	X																																	
Lefkoweld 40LM 52	X	X																																	
MF500F-124 Microwave Absorber	X	X			X																														
Paint, Cat-A-Lac 473-3-1/x304	X	X																																	
Paint, Brolite Gloss Black Enamel	X	X																																	
Paint, Brolite Gloss White Enamel	X	X																																	
Paint, Nextel 401-C10	X	X																																	
Scotchcast 241	X	X																																	
Scotchcast 583 Tape	X	X																																	
Skyspar A423/66	X	X																																	
SMRD 100F-90	X	X																																	
Stycast 36D	X	X																																	
Stycast 1263/Cat. 31	X	X																																	
Stycast 2651/Cat. 9	X	X																																	
Stycast 2651/Cat. 11	X	X																																	

*Numbers refer to tests listed on pp. iv and v.

Material Test Index

NAME	TESTS PERFORMED*																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Torr Seal A/B	X	X																																	
Trucast 111M/901	X	X																																	
Trucast 111M/902	X	X																																	

*Numbers refer to tests listed on pp. iv and v.

Application Index

Page

ADHESIVES:

Ablefilm 501-1 15
Ablefilm 535-1 18
Armstrong A2/Act E 23
Bacon FA13/BA-39 26
BLH-EPY 500 32
Bondmaster E645 35
CMC-15 Bonding Film 41
EA901/B3 57
EA956 60
EA9320 62
EA9414 65
Eccobond 56C/Cat.11 68
ECF-550 80
Epocast 203 86
Epon 815/A 89
Epon 828/Versamid 125 97
Epo-Tek H43 102
Epo-Tek H72 105
Epo-Tek 417 108
Epo-Tek 417 111
FM-40 120
FM-96 Supported Film 123
HT435 Film Adhesive 130
Hysol AS-7-4315 133
LCA-4V/BA-5 184
Lefkoweld 46LM 52 187

COATING, FINISHES, INKS:

ADX-41 21
C7-4248 38
Coating G2735 on Electromagnetic Core 44
Coating S8993-8Q$_2$ on Electromagnetic Core 46
Eccocoat EP-3 71
Hysol C9-4183/H2-3561 136
Ink, Cat-L-Ink 50-100-Cat. 20 145
Ink, Cat-L-Ink 50-300-9 148
Ink, Cat-L-Ink 50-407-9 151
Ink, M-9-N/Cat. A 154
Ink, Markem 7224 157
Ink, M-O-N, Black 160

Application Index (Continued)

Page

Ink, 50-507-9, Red 163
Ink, 50-202-9, Yellow 166
Paint, Cat-A-Lac 473-3-1/x304 193
Paint, Brolite Gloss Black Enamel 195
Paint, Brolite Gloss White Enamel 198
Paint, Nextel 401-C10 201
Skyspar A423/66 209

ELECTRICAL INSULATION:

BC-328A/BC-328C 29
E300 Insulating Film 54

ENCAPSULANTS AND SEALANTS:

Conductive Epoxy 5504A 48
Conductive Epoxy 8294 51
EA9414 65
Eccoseal 1207/20 74
Epon 815/A 89
Epon 828/Cat. 2/Flex 871 91
Epon 929 100
ES-222 117
High Temp 221 127
Hysol AS-7-4315 133
Hysol R9/H2 139
Impregnant 3-BA-4 142
Scotchcast 241 204
SMRD 100F-90 212
Stycast 36D 215
Stycast 1263/Cat. 31 218
Stycast 2651/Cat. 9 221
Stycast 2651/Cat. 11 224
Torr Seal A/B 227
Trucast 111M/901 230
Trucast 111M/902 233

LAMINATES, COMPOSITES:

EG818T 83
Epon 828/MPDA/120 Fiberglass Cloth 94

Application Index (Continued)

Page

Epoxy 430 Tubing 114
Laminate, Epoxy/Glass 102-21 169
Laminate, Mil-P-13949 FL-GFN.............................172
Laminate, E-787..174
Laminate, G-10 FR Clad 176
Laminate, G-10, FR Unclad 179
Laminate, L-P-509 GR G-11...............................182

TAPE:

Scotchcast 583 Tape 207

THERMAL INSULATION:

Eccostock R-25 77

MISCELLANEOUS:

MF 500F-124 Microwave Absorber...........................190

INTRODUCTION

This handbook is a compilation of chemical and physical property test data obtained during qualification and receiving inspection testing of nonmetallic materials for the Viking Mars Lander (NAS1-9000) program at the Denver Division of Martin Marietta Corporation. The compilation presented here is unique in that all tests have been carried out by one group of test personnel. This familiarity with all test procedures and materials minimizes the possibility of unintentional modifications of test techniques and misinterpretation of data and their presentation.

The information presented has, as a minimum, thermochemical data showing degradation as a function of temperature from room temperature through 773°K (500°C). These data include activation energies for thermal degradation, rate constants, and exo- and/or endotherms. Thermal degradations carried out under vacuum include mass spectral data taken simultaneously during the decomposition. Many materials have supporting data such as condensation rates of degassed products and isothermal weight loss. Changes in mechanical, electrical and thermal properties after exposure to 408°K (135°C) in nitrogen for times ranging from 380 to 570 hours are included for many materials.

Over 400 organic/polymeric materials were considered for use throughout the Viking Mars lander capsule program. Considering the variety of mechanical, electrical and thermal property measurements required, conventional vacuum tests techniques would be prohibitive from the standpoint of both cost and schedule. Unique facilities for determining physical properties in-situ were developed to handle the environmental exposure and material qualification test requirements established for the Viking Mars lander capsule. Since the capsule was almost completely inactive during cruise from Earth to Mars and few mechanical or electrical stresses are developed during this phase, the thermal vacuum environment was the only simulation required. The system developed separated the environmental conditioning from testing and provided for transfer of specimens between conditioning and testing chambers without exposure to atmosphere. It is described later.

DISCUSSION OF TEST METHODS

I. Thermochemical Data

A. TGA: Thermogravimetric analysis (TGA) is the continuous weighing of a sample while it is being heated at a fixed heating rate, e.g., 10^oK/min. During this process, the sample loses weight continuously, beginning and ending at temperatures peculiar to the sample material. Figure 1 is a schematic of the system used.

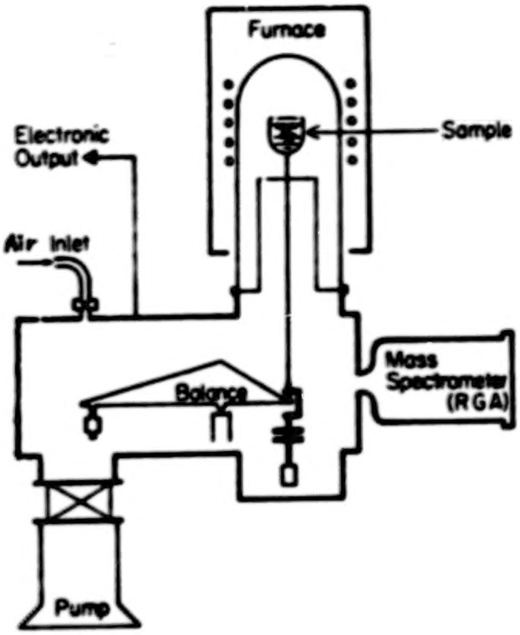

Figure 1
Schematic of TGA-RGA
Apparatus

Figure 2 shows the TGA curve for a silicone. This material thermally decomposes in a two-step process; the dotted line depicts the end of the first reaction. The second reaction may be the decomposition of the product of the first reaction or it may be different component of the original material.

The simple first-order kinetic equation

$$\frac{dx}{dt} = \frac{k_T}{(a_o-x)} \qquad (1)$$

has been found to be adequate for describing the decompositions. In this equation, k_T is the rate constant at temperature T, dx/dt is the rate of weight loss, x is the weight loss, and a_o is the initial amount of the "active component". The active component is that portion of the original weight of the sample that participates in decomposition. For decompositions with a simple TGA curve, the active component is taken as the total weight loss. For polymers where the TGA shows the degradation to be more than a one-step decomposition as in Figure 2, the initial weight of the active component a_o is taken as that portion of sample weight participating in the step. In Figure 2, these are designated as $(a_o)_1$ for the first decomposition and $(a_o)_2$ for the second step. In utilizing equation (1), the thermoanalyzer yields dx/dt from the DTG output, which is the electronically determined slope of the TGA, x is obtained from the TGA curve, and a_o as described.

The rate constant is given by the "Arrhenius relationship"

$$k = A \exp \frac{-E}{(RT)} \text{time}^{-1} \qquad (2)$$

where A is a constant, usually called the frequency factor, R is the universal gas constant, T is the absolute temperature, and E is an energy term known as the activation energy of the process. If the rate constants, experimentally determined at several temperatures, from Equation (1) are plotted against the reciprocal of absolute temperature (^{o}K), the result is the Arrhenius relationship depicted in Figure 3. The slope of this plot yields the activation energy of the decomposition. Figure 3 shows the results obtained for the first reaction step of the decomposition for the silicone depicted in Figure 2. The points on the plot are representative of the very large number of data points available from the TGA-DTG output of the thermoanalyzer. The larger slope is the activation energy for the decomposition of the polymer associated with $(a_o)_1$. The smaller slope results from degassing of "solvent" such as unreacted monomer, catalyst,

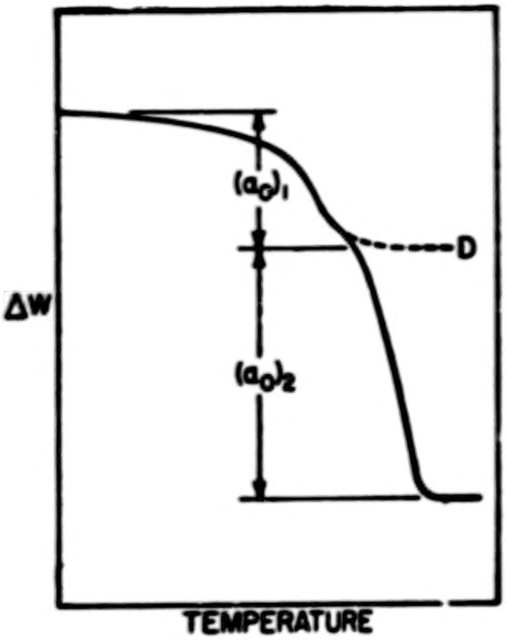

Figure 2
TGA Curve for a Silicone

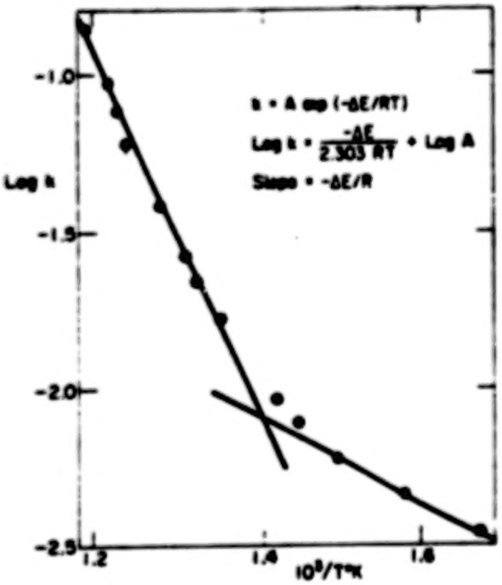

Figure 3
Arrhenius Relationship
Obtained from TGA Curve

etc. At the lower temperatures of the TGA test where this slope appears, x in Equation (1) is predominantly "solvent" loss whereas the amount of "solvent" is so small with respect to the amount of polymer that it does not affect a_o for the polymer degradation. Thus, when the "solvent" is degassed during the early stages of the TGA test, the Arrhenius relationship reverts to that for the degradation of the polymer itself.

Integration of the rate equation, Equation (1), yields

$$a_o - x = a_o e^{-kt} \tag{3}$$

where t is time. Then

$$\frac{a_o - x}{a_o} = e^{-kt} \text{ is the fraction remaining.} \tag{4}$$

Thus, when k is determined for a particular temperature, one can get the fraction of material remaining after a time, t,

$$1 - e^{-kt} \times 100 = \%\text{ weight loss.} \tag{5}$$

As an example consider the question, what is the time required for a 1% weight loss at 423°K (150°C) for a silicone such as that depicted in Figure 2? From information given for the material in the Data Section, we find that

$$k_T = 0.8 \exp \frac{-6720}{(RT^oK)} \text{ min}^{-1}$$

Therefore

$$k_{423^oK\ (150^oC)} = 0.8 \exp \frac{-6720}{(1.98 \times 423)} = 2.63 \times 10^{-4} \text{ min}^{-1}.$$

For 1% weight loss, the fraction remaining is 0.99 so e^{-kt} =

0.99, from which we find that kt = 0.01. Thus the time required is

$$t = \frac{0.01}{2.63\times10^{-4}} = 38 \text{ min.} = 2.3 \times 10^{3} \text{ s.}$$

Figure 4 compares TGA results on approximately 10 mg of Dacron parachute material with an isothermal decomposition on approximately 4 gm of material at near normal use temperatures. The excellent agreement with the prediction of TGA is evident. It should be noted that the TGA is able to predict rate constants at some 300°K lower temperature on realistically sized samples. Predictive capability has been found for all materials so compared (see "Prediction of Polymer Degradation Kinetics at Moderate Temperatures from TGA Measurements", H. Papazian, J. Appl. Polym. Sci., 16, 2503, 1972).

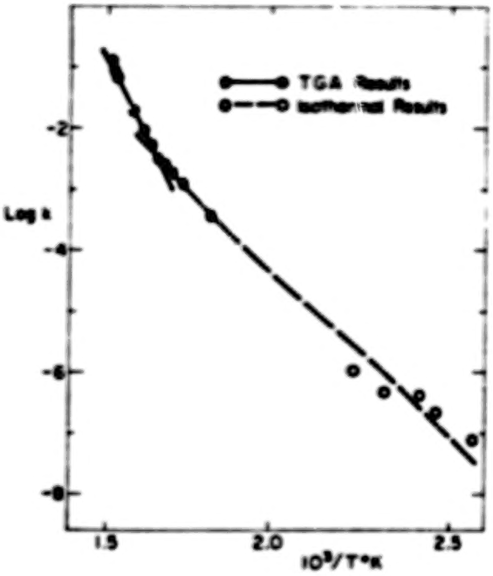

Figure 4
Arrhenius Relationship Comparing TGA and Isothermal Results for Dacron

When the cure and postcure of two different batches of the same polymer are carried out in the same manner, the TGA curves are identical.

TGA tests were run at heating rates of 10°K/min for both the vacuum and nitrogen tests. Samples were prepared as small particles scraped or cut to size to approximately 10 mg of total weight. Samples were preconditioned prior to TGA tests in several ways and are discussed for each material in the data section. For the nitrogen TGA tests, the flow rate of the nitrogen was 5.2 l/hr. During vacuum TGA tests, mass spectra were taken at 1-minute intervals (i.e., every 10°K).

The TGA data in this document are presented in graphical form, similar to Figure 2, giving weight loss vs. temperature from ambient to 773°K (500°C). A second curve having 10 times the sensitivity of the standard TGA curve is used to give an accurate display of the first 10% of weight loss. This will give details of the early portion of the decomposition, which may be of importance in determining low temperature degassing, water absorption, etc.

B. Mass Spectra - Mass spectrometry, sometimes referred to as residual gas analysis (RGA) or evolved gas analysis (EGA), has been used to qualitatively characterize the volatile species as they are generated during the TGA test.

When a volatilized molecule enters the ionization chamber (or region) of a mass spectrometer, it is impacted by energetic (70-eV) electrons. The molecule is thereby fragmented into its mass spectrum. This mass spectrum is characterized by masses and their intensities. For example, H_2O is fragmented into masses 18 (H_2O+), 17 (OH+), 16 (O+) in the intensity ratio 18 = 100, 17 = 26, 16 = 6. Whenever a mass spectrum is observed with the masses 18, 17, and 16 in the intensity ratio 100, 26, and 6, it may be identified as water.

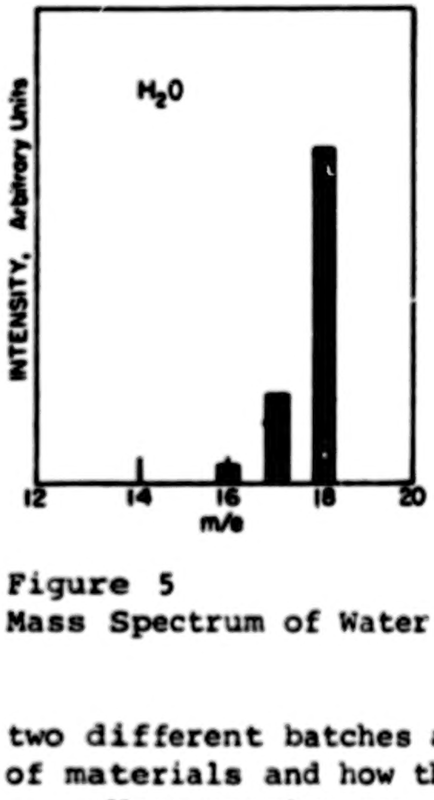

Figure 5
Mass Spectrum of Water

Figure 5 depicts the mass spectrum of H_2O obtained with 70-eV electrons. The abscissa is labeled m/e to be consistent with the usual presentations. The ratio of mass-to-charge, m/e, is what is actually measured in the mass spectrometer. Since it is unusual for the charge e to be equal to 2, the m/e ratio is usually the mass number or mass fragment. For simple molecules the analysis is quite simple. With increasing molecular weight and therefore increasing complexity of the molecule, the complexity increases accordingly. In mixtures of such molecules, as are present in most polymeric systems, the analysis is exceedingly difficult. However, mass spectra used in conjunction with TGA data permit determination as to whether samples from two different batches are identical. This permits comparison of materials and how they were processed.

Mass spectra can also be useful in determining degassing prior to thermal decomposition. For example, one can determine how much H_2O, solvent, unreacted monomer, etc., remain in the material after processing, e.g., cure, postcure.

On all TGA tests under vacuum, mass spectra are taken at 1-minute intervals, i.e., every 10^oK. Since it is impractical to present these voluminous data, approximately five temperatures are chosen along important parts of the TGA curve and mass spectra at these temperatures are presented in tabular form.

C. DTA: Differential thermal analysis (DTA) indicates the heat changes taking place during the decomposition. An exotherm indicates a release of heat, and an endotherm indicates the absorption of heat. This information is useful in determining the mechanism of the decomposition reaction.

DTA curves are obtained simultaneously with the TGA under nitrogen and are presented in graphical form for each material.

D. Isothermal Weight Loss in Nitrogen: The purpose of this test was to simulate the Viking lander sterilization conditions.

Samples were preconditioned for 24 hours at 296^oK (23^oC) in 45% RH for a baseline condition. Approximately 2 to 5 gm of sample was weighed and placed in a gastight system at 408^oK (135^oC). Nitrogen flowing at 5.2 l/hr. was passed over the sample for 100 hrs. ($3.6 \times 10^5 s$) after which the sample was weighed to determine the weight loss.

E. Condensible Outgassing: In many situations it is important to know what products of outgassing from a material are condensible, thereby leading to contamination of, for example, optical surfaces.

Condensible degassing rates onto a gold-plated quartz substrate cooled to 148^oK (-125^oC) were determined using a quartz crystal microbalance (QCMB). In this test, a 2 to 5 gm sample was placed in a small vacuum furnace and the temperature was elevated to 325^oK (52^oC) (max mass lander temperature anticipated). The furnace was then sealed except for a small orifice above which the cooled QCMB was located. The condensation rate was monitored continuously until a constant deposition rate was established, the time ranging from 1 to 4 days.

Figure 6 is a schematic diagram of the test apparatus.

The results are presented in tabular form showing condensation rate (as % of original sample weight per day), temperature of the sample, and the duration of vacuum exposure prior to outgassing tests.

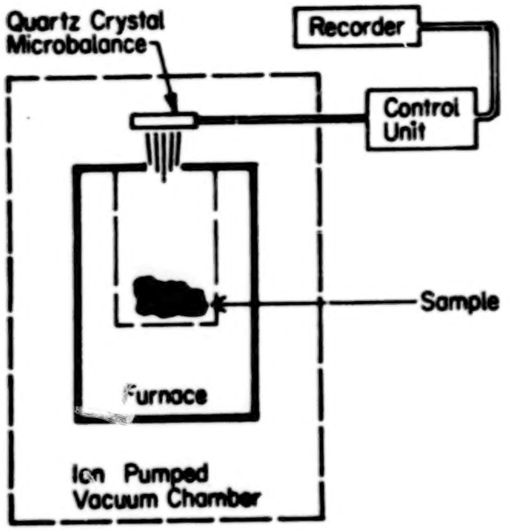

Figure 6
Schematic of Condensible Outgassing Products

II. Physical Property Tests

Twenty-nine different physical properties have been measured, each material being tested for its particular use. These tests are listed in Table 1 on Pages iv and v. Points at which property determinations were made include before and after heat compatibility and after a 1-month thermal vacuum exposure, with some data at 3-, 6-, and 14-month thermal vacuum exposures. The results for any material are presented in tabular form showing the property measured against the parameter of interest and the ASTM or FTMS designation for the test procedure.

The thermal vacuum exposures were carried out in individual canisters. Four canisters were coupled directly to 50 l/s ion pumps and the remaining 28 were connected to 7-canister plenums, with each plenum attached to a 400 l/s ion pump. Each system was capable of maintaining pressures in the 10^{-7} to 10^{-8} torr range.

Two 63.5 mm high vacuum valves between the canister and vacuum plenum permitted the canister to be removed from the pumping system and transferred to the test chamber without altering the pressure in the canister or plenum. A recirculating hot water heater maintained canister temperatures between ambient and 339°K (66°C).

The test chamber was constructed of 300 series stainless steel and consisted of two individual vacuum chambers separated by a .61 m sliding gate valve. The main chamber was a nominal 1.5 m in diameter and 2.1 m long. The airlock chamber was .61 m in diameter and .61 m long, and a full opening door at the other end provided easy access to the chamber.

The .56 m^2 chamber view window had three tempered glass sections each laminated of two layers of 19 mm thick glass. Twenty-nine flanges on the main chamber ranged in size from a 38 to 203 mm tube size. The flanges were fitted with feed-throughs for high voltage, coaxial, high current, instrumentation, liquid nitrogen, and nude ion gages.

Three master/slave manipulators enabled access to over 90% of the chamber while it was evacuated. The manipulators were similar to those used in nuclear installations and each consisted of four major parts--the master arm, the slave arm, the seal tube assembly, and the tongs. Tong configurations could be changed remotely using a special fixture. The manipulators provided six degrees of freedom and had electric indexing in two axes for displacement of the master arm relative to the slave arm. All other motions were mechanical, with a one-to-one force ratio between the master arm and the slave arm except for the friction of the motion rods within the seal tube assembly. Figure 7 shows the chamber and manipulators.

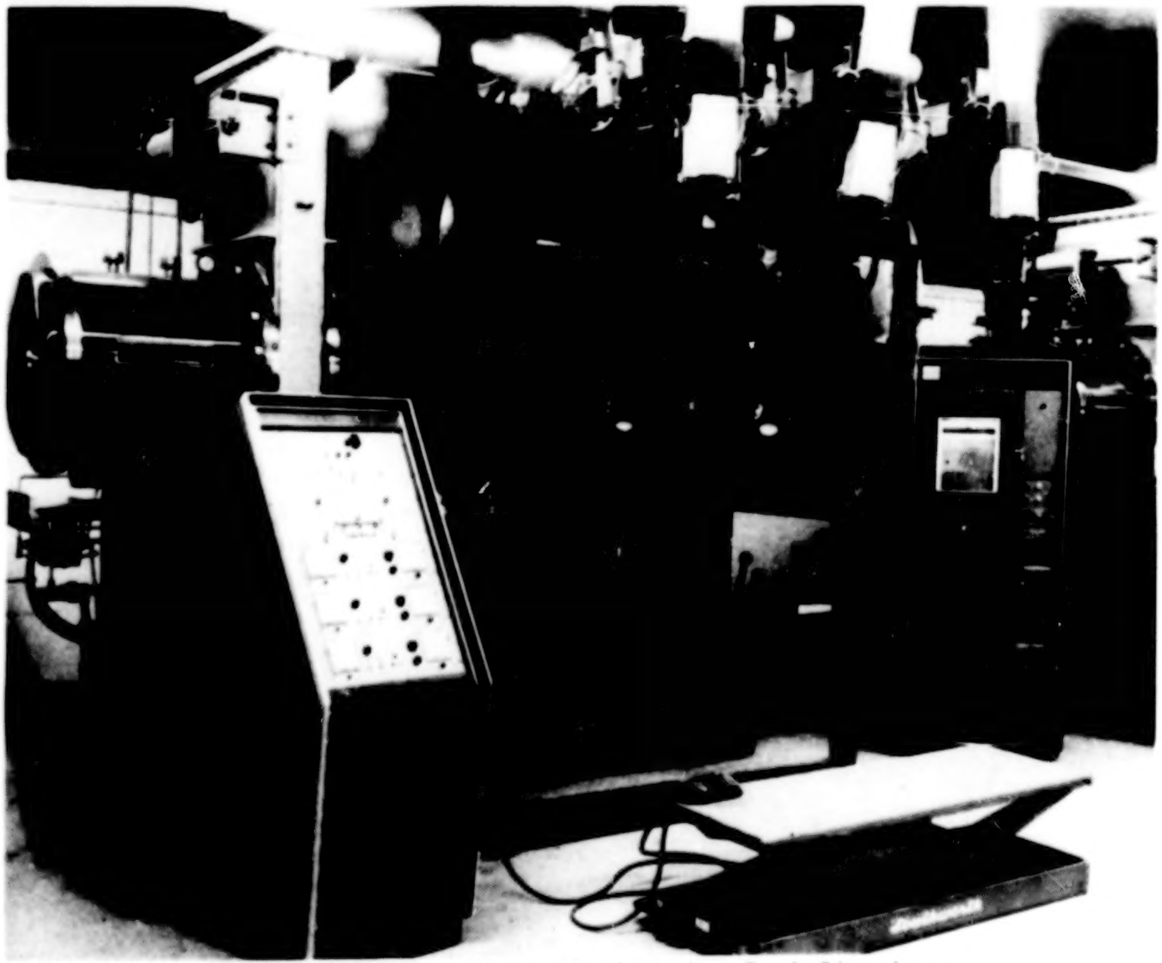

Figure 7.-Master-Slave Manipulator Test Chamber.

A 4,500 kg universal test machine was coupled to the main chamber. The columns were shock isolated from the chamber with bellows, and the moving crosshead pull rod was attached to a bellows with a 35 cm stroke capability. Tensile, compression, flexure, and shear tests have been performed in this chamber. Electrical property tests, including dielectric strength, dielectric constant, and surface and volume resistivity, have been accomplished with the aid of special fixturing developed for use in vacuum with the master/slave manipulators. Thermal expansion measurements of heat shield materials have been made using fixtures designed to be handled with manipulators. Heating and cooling of test specimens was provided by radiant heaters (quartz lamps) and liquid nitrogen-cooled shrouds.

III. Qualification Criteria Used for Viking Materials

All proposed materials were given a screening TGA. There were no criteria for this test except judgment as to thermal stability. This judgment was based on how much weight loss occurred at the sterilization temperature and the temperature of the beginning of major decomposition of the material.

Once a material passed screening, qualification of the material for the Viking program was undertaken. The material was subjected to tests of (1) isothermal weight loss in N_2 and (2) condensible outgassing. If the isothermal weight loss was greater than 1%, the material was rejected. If the condensible outgassing rate was greater than 1×10^{-4}%/day, the material was rejected. If the material passed these criteria, it was permitted to undergo the physical property qualification tests that depended on the proposed use of the material. The criteria for the physical property qualification were determined by the design parameters for the material.

A TGA-RGA analysis was carried out as a baseline for comparison with all subsequent lots or batches of material. Rejection of an incoming sample occurred if:

1) The TGA curve of the new sample presented a total mismatch with the baseline curve;

2) The TGA weight loss in the temperature range between 298°K (25°C) and 408°K (135°C) was more than 2% of the baseline TGA;

3) The RGA data showed major mass fragments different from

the baseline major mass fragments;

4) The RGA data between 298°K (25°C) and 408°K (135°C) showed mass fragments greater than m/e = 44 not present in the baseline RGA;

5) When the onset of major degradation varies more than 50 to -20°K from the baseline onset;

6) When the total weight loss (through major degradation) of composites indicates a filler content variation of greater than 5%.

During the course of the program changes in technical direction eliminated or modified some qualification tests so that not all materials reported here have the same data available.

Use of trade names or names of manufacturers in this report does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the National Aeronautics and Space Administration, nor does it imply that the materials are necessarily the only ones or the best ones available for the purpose.

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DATA SECTION

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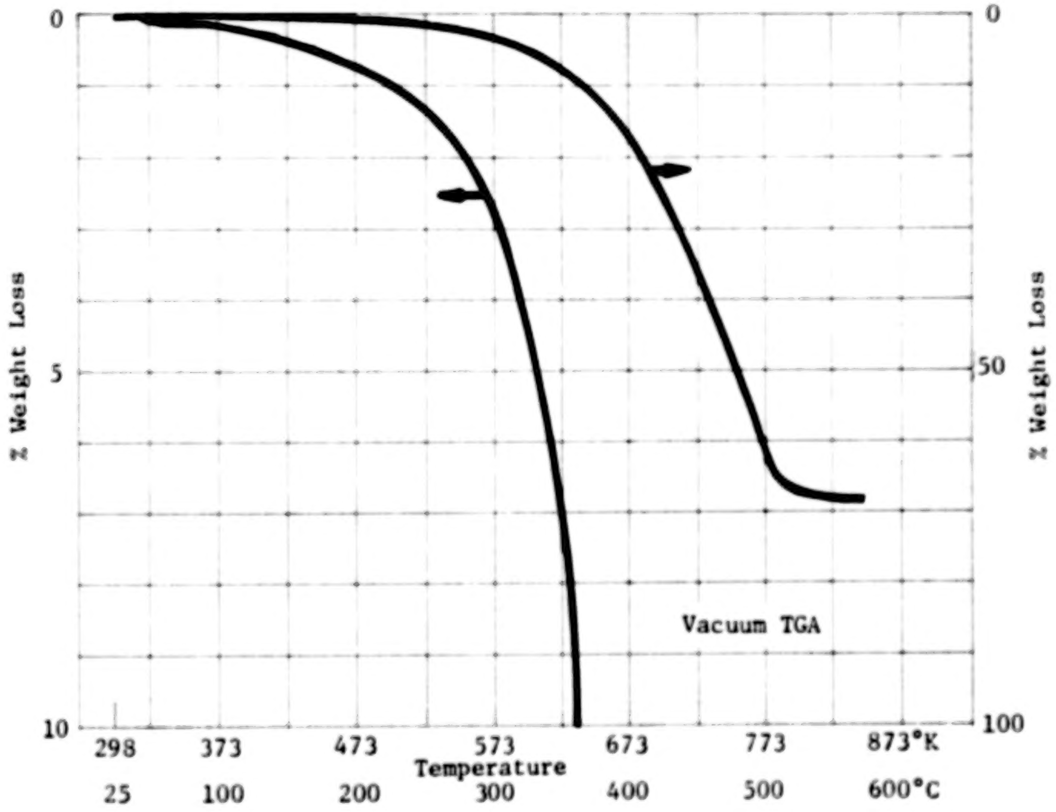
Ablefilm 501-1

Chemical Characterization Summary

Mix Ratio: **As received film**
Cure: **3 hrs. at 347°K (73°C), 1 hr. at 408°K (135°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **298°K (25°C) - 548°K (275°C)**

$a_o = 7.6\%$ of initial weight

$$k = 1.9\text{x}10^5 \ \exp\left(\frac{-16800}{1.98\ T°K}\right) \ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	8.3 x 10^5	
373°K (100°C)	2.4 x 10^4	
423°K (150°C)	1.6 x 10^3	

Isothermal weight loss in nitrogen-0.85%

Number and Relative Peak Intensity

Temperature, °K (°C)

Ablefilm 501-1

m/e	298 (25)	473 (200)	573 (300)	698 (425)	773 (500)		
14	1202	1180	1427	5586	1543		
15	585	624	1224	14082	1779		
16	3978	3660	3789	6427	3890		
17	11584	9380	9271	11079	8290		
18	35873	28021	27218	31973	22965		
19	156	149	174	549	122		
20	296	292	284	374	263		
21							
22							
23							
24			101	604	106		
25	52	62	275	2183	319		
26	239	267	1392	8873	1493		
27	504	530	1895	11145	1866		
28	12958	12442	14709	31474	14268		
29	241	300	1284	22941	1879		
30	738	734	868	5385	1006		
31			139	4510	357		
32	3294	2893	2774	2886	2432		
33							
34		40					
35			111				
36			284	559	112		
37			194	2756	253		
38		46	269	4690	429		
39			396	14195	1437		
40	2301	2244	2342	7614	2535		
41	81	93	393	6987	932		
42	64	90	414	5735	666		
43	88	126	1043	22943	1574		
44	767	870	1304	5849	1008		
45		52	129	3858	346		
46				304			
47			45	749	66		
48			41	142			
49			109	731	92		
50		47	198	3044	395		
51			95	3042	446		
52			110	1107	205		
53			90	1993	268		
54			93	492	77		
55			341	3033	288		
56			390	1023	154		
57			100	1835	192		
58			90	2696	278		
59			40	1635	133		
60			43	416	47		
61				922	88		
62				1275	134		
63				2420	289		
64	44	45		806	102		
65				5647	425		
66	51	53	70	7237	428		
67			47	693	80		
68			56	367	50		
69			81	328	66		
70				206			
71				217			
72				570	46		
73				607	60		
74				891	90		
75				427	62		
76				322	51		
77			45	2195	398		
78			50	845	191		
79			42	1154	203		
80				294	54		
81				150			
82				93			
83				98			
84	67	73	72	138	59		
85				146			
86				144			
87				369			
88				57			
89				405	67		
90				378	69		
91				1381	337		
92			89	262	74		
93				421	42		
94				9932	492		
95				731	43		
96				96			
97				43			
98				51			
99				66			
100				87			
101				147			
102				124			
103				367	67		
104				102			
105				316	94		
106				89	42		
107				1630	305		
108				851	163		
109				79			
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113							
114				54			
115				225			
116				77			
117				130			
118				109			
119				397			
120				153			
121				805	118		
122				226	45		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

Ablefilm 501-1

m/e	298 (25)	473 (200)	573 (300)	698 (425)	773 (500)		
128				42			
129	82	73	68	80	52		
130							
131	55	61	54	213	64		
132	67	67	62	135	57		
133				164			
134				280			
135				122			
136				172			
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145				50			
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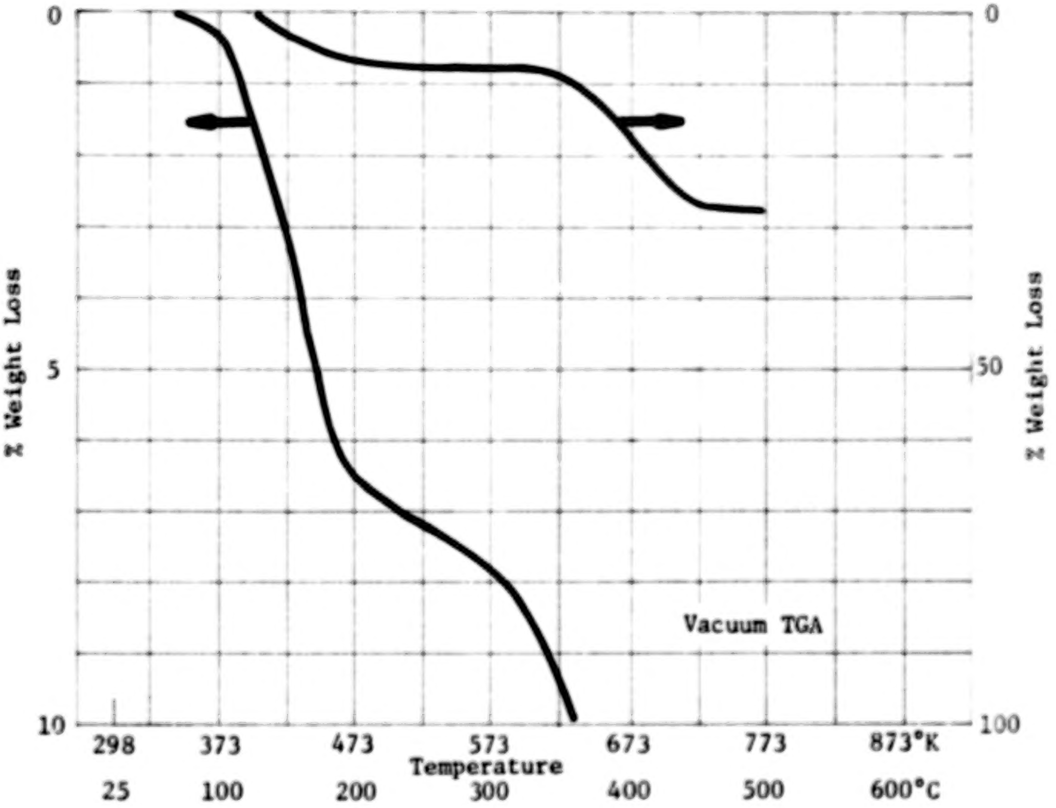
Chemical Characterization Summary

Mix Ratio: **As received film**
Cure: **2 hrs. at 398°K (125°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: 523°K (250°C)-723°K (450°C)

a_o = **19.5% of initial weight**

$$k = 1.65 \times 10^{11} \exp\left(\frac{-36600}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**2.5×10^{13}**	
373°K (100°C)	**1.2×10^{10}**	
423°K (150°C)	**3.3×10^{7}**	

Number and Relative Peak Intensity

Temperature, °K (°C) Ablefilm 535-1

m/e	298 (25)	423 (150)	523 (250)	673 (400)	773 (500)		
14	488	1016	985	1589	1411		
15	283	388	364	1531	872		
16	1110	2146	2220	3100	2692		
17	5805	6829	6929	7063	7387		
18	21843	24913	30973	31343	27728		
19		46	70	81	55		
20	154	135	260	288	198		
21							
22				56			
23							
24				174	57		
25		129	94	945	293		
26	566	918	985	4336	1862		
27	763	1073	1263	5187	2594		
28	27325	37148	39496	48912	48514		
29	750	1033	1170	6189	2951		
30	347	491	586	1700	899		
31	107	117	131	1256	461		
32	4533	5586	5877	5609	6739		
33							
34							
35							
36				168			
37				1281	158		
38	50		68	2229	340		
39	104	165	233	6643	1179		
40	2336	3194	3602	6623	4187		
41	166	202	168	2289	927		
42	169	139	183	2669	601		
43	1182	1442	1725	5517	2631		
44	756	1247	1965	6537	2007		
45	45	96	55	868	330		
46				87			
47				302			
48							
49				253			
50		73	41	1317	215		
51			40	1247	197		
52				434	40		
53				606	80		
54				196	41		
55				1361	122		
56				414	96		
57			74	587	144		
58				528	168		
59				73			
60				59			
61				212			
62				352			
63				629			
64				144			
65				1629	77		
66				2536	63		
67				281			
68				105			
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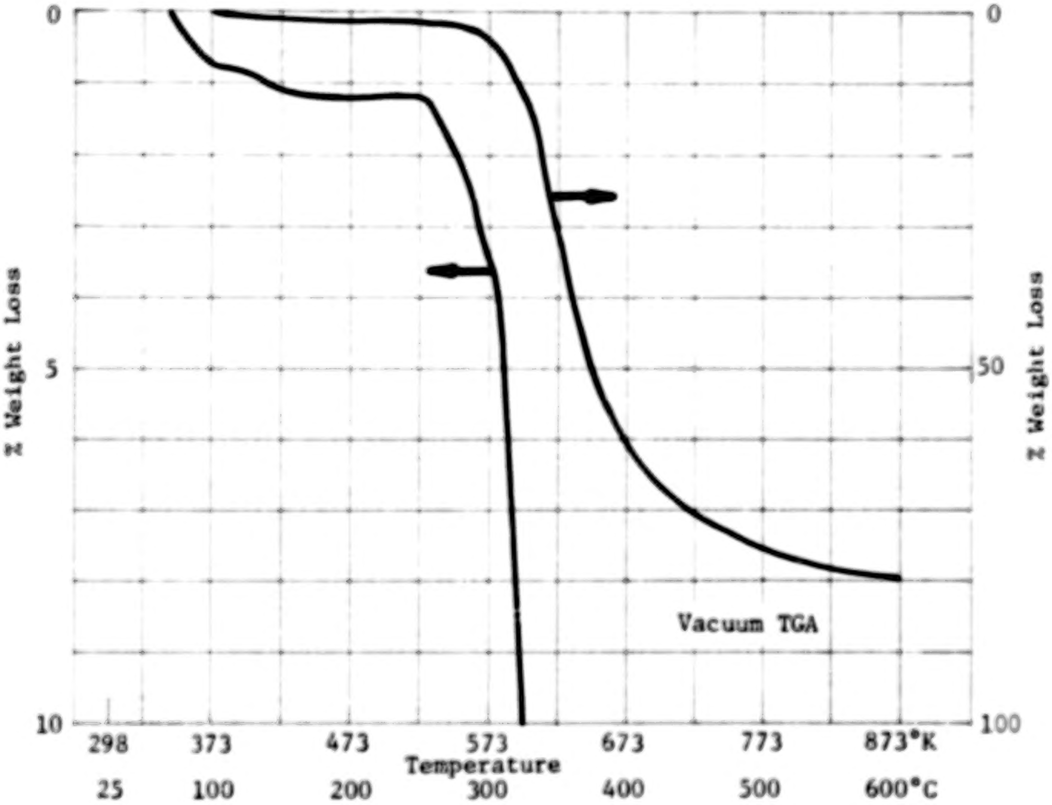
Chemical Characterization Summary

Mix Ratio: **One Component**
Cure: **4 hrs. at $394^\circ K$ ($121^\circ C$)**

1. TGA Preconditioning: **24 hrs. at $296^\circ K$ ($23^\circ C$) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **$473^\circ K$ ($200^\circ C$)-$773^\circ K$ ($500^\circ C$)**

a_o = 51.9% of initial weight

$$k = 1.2 \times 10^{13} \exp\left(\frac{-39200}{1.98\ T^\circ K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
$323^\circ K$ ($50^\circ C$)	2.0×10^{13}	
$373^\circ K$ ($100^\circ C$)	5.5×10^{9}	
$423^\circ K$ ($150^\circ C$)	1.0×10^{7}	

Number and Relative Peak Intensity

Temperature, °K (°C) HDB-41

m/e	298 (25)	573 (300)	623 (350)	673 (400)	873 (600)		
14	662	1386	2476	1907	1653		
15	76	2701	6344	4293	5126		
16	1287	18097	13064	7934	8979		
17	9029	28655	26147	17206	10221		
18	35267	62942	64962	47449	35312		
19	140	138	292	240	94		
20	84	112	178	147	168		
21							
22		507	76				
23							
24		86	586	514	43		
25		472	2815	2640	215		
26	103	3772	15382	14868	1902		
27	300	5812	20115	20094	3636		
28	21776	46144	50066	44544	29068		
29	333	3234	9006	7815	1371		
30	231	4552	6369	3460	764		
31	146	1917	3759	2112	247		
32	5976	5886	5751	5867	5659		
33			40	92			
34							
35		40	62				
36		72	564	663	61		
37		606	4097	4270	139		
38		1410	7670	8149	423		
39	61	5214	26535	28055	1739		
40	438	3804	9474	9033	1240		
41	106	2632	10252	11453	1009		
42	78	7381	8750	5843	669		
43	149	3338	9763	7910	828		
44	939	100238	31839	13755	2292		
45	46	2363	2042	1261	166		
46		410	338	281	62		
47			778	569			
48		44	199	230			
49		195	2157	2230			
50		1586	11642	13623	72		
51		1598	15292	19563	585		
52		1676	10106	10595	660		
53		976	10890	11052	637		
54		608	4645	4444	482		
55		372	5580	5478	227		
56	49	681	1877	1405	339		
57		391	1364	906	136		
58		849	1021	834	118		
59		257	438	244	44		
60		57	603	514			
61			1947	2034	49		
62		62	3094	3771	106		
63		175	6774	6705	306		
64		170	2383	2724	117		
65		612	11246	12980	442		
66		951	11211	10811	357		
67		977	3376	3374	88		
68		122	1640	1532	57		
69		40	346	404	47		
70		63	309	264			
71		50	98	108	43		
72		56	100	139			
73		87	558	647	45		
74			2143	2939	41		
75			1243	1681	50		
76			1223	1898	50		
77		202	11705	15925	311		
78		263	7444	10906	523		
79		850	7045	8930	159		
80		4[illegible]7	8674	6865	445		
81	41	426	3129	2677	132		
82		57	725	658			
83			71	105			
84			109	86			
85			81	119			
86			114	170			
87			135	235			
88			54	57			
89			1305	2087			
90			1576	2129			
91		64	7844	17798	584		
92		185	2174	4968	295		
93		629	2204	2135	47		
94		847	15025	13825	345		
95		94	1597	1277	44		
96			152	173			
97							
98				57			
99			54	43			
100							
101				62			
102			367	732			
103			2644	4496			
104		43	4933	7690	49		
105			1312	2754	47		
106		76	919	1333	42		
107			9426	11639	104		
108		1143	7144	8087	92		
109			4503	3330	206		
110		55	195	149			
111							
112							
113							
114							
115							
116			210	518			
117			85	133			
118			57	765			
119			398	620			
120			342	127			
121			112	187			
122		58	1527	2018			
123		114	1880	2025	40		
124			580	382			
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) AIR-41

m/e	298 (75)	573 (300)	623 (350)	673 (400)	873 (600)		
128				44			
129				43			
130				47			
131				81			
132			55				
133							
134			45	54			
135							
136			60	79			
137			162	152			
138							
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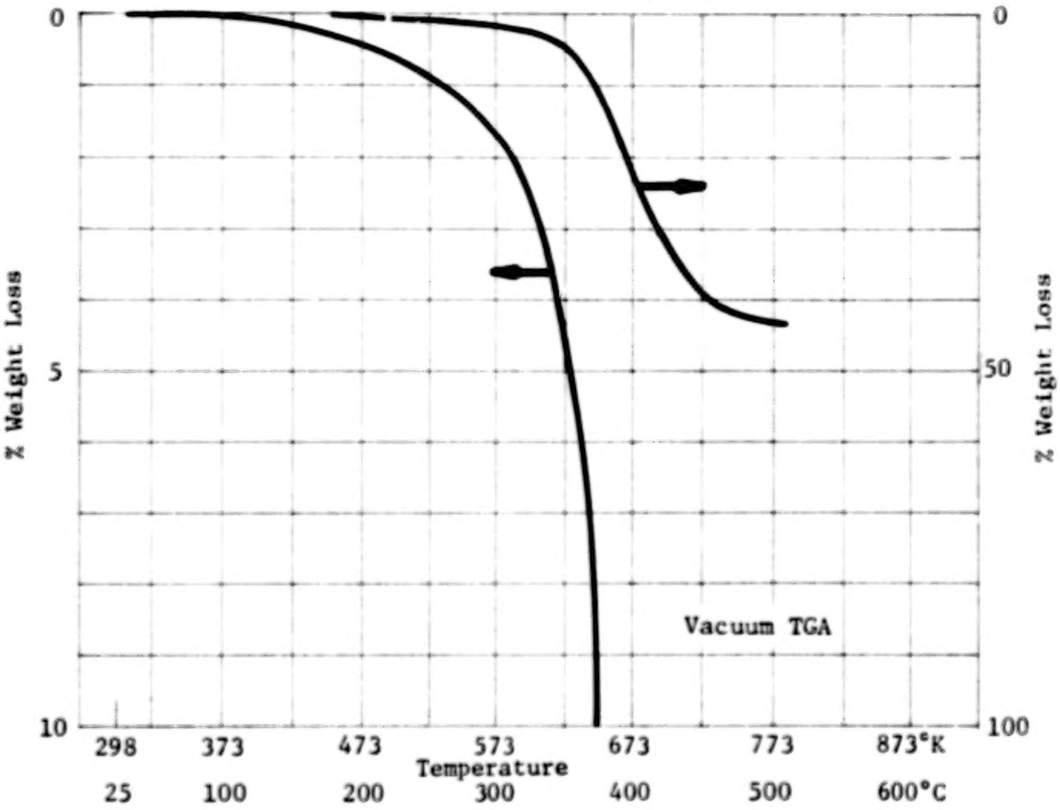
Chemical Characterization Summary

Mix Ratio: **100 pbw of A2 Resin to 6 pbw of Activator E**
Cure: **4 hrs. at 405°K (132°C)**

1. TGA Preconditioning: **100 hrs. at 398°K (100°C) in N_2 atmosphere**
24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-773°K (500°C)**

a_o = **33.5%** of initial weight

$$k = 4.7 \times 10^9 \ \exp\left(\frac{-30800}{1.98\ T°K}\right)\ \text{min}^{-1}$$

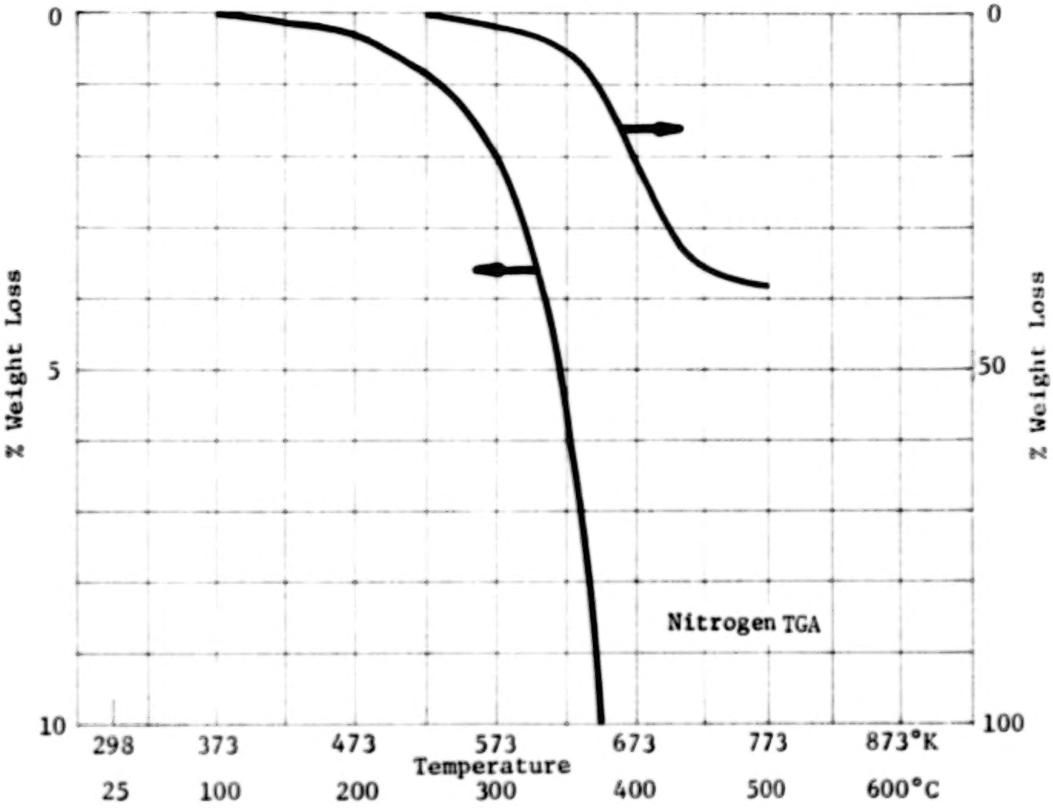
Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	9.8×10^{10}	2.0×10^{7}
373°K (100°C)	1.6×10^{8}	2.9×10^{5}
423°K (150°C)	1.1×10^{6}	1.2×10^{4}

Chemical Characterization Summary

Mix Ratio: 100 pbw **A2 Resin to 6 pbw Activator E**
Cure: 4 hours at 405°K (132°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 523°K (250°C) - 773°K (500°C)

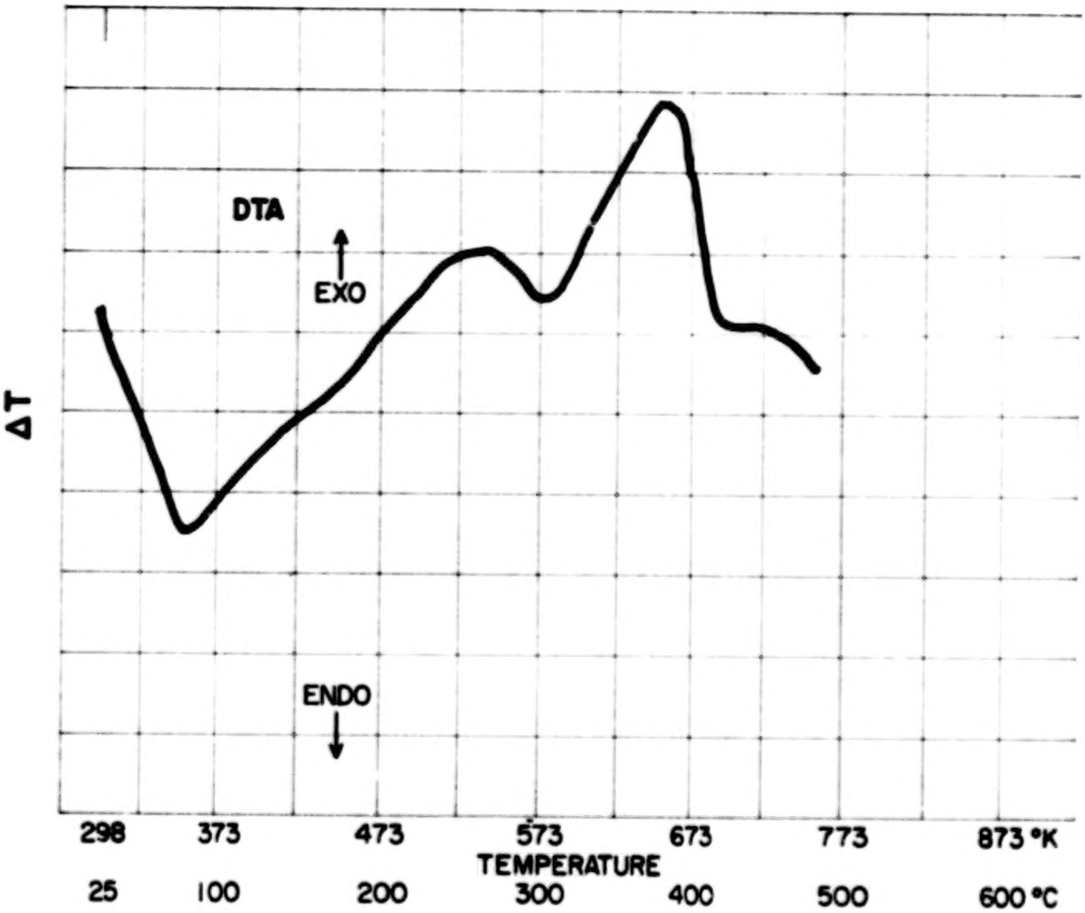
a_o = 31.7% of initial weight

$$k = 1.35\times10^{6}\ \exp\left(\frac{-20{,}100}{1.98\ T^{\circ}K}\right)\ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)		2.0×10^{7}
373°K (100°C)		2.9×10^{5}
423°K (150°C)		1.2×10^{4}

Armstrong A2/Act. E



Number and Relative Peak Intensity

Temperature, °K (°C) Armstrong A2/ACT E

m/e	298 (25)	473 (200)	573 (300)	623 (350)	673 (400)	773 (500)	
14	640	711	852	1801	1687	835	
15	152	204	915	5120	3785	958	
16	1889	1703	2243	4121	3079	2338	
17	12597	10066	14019	15917	12297	8506	
18	46861	36645	51976	55781	43809	30465	
19		47	64	95	102	42	
20	101	92	107	131	126	81	
21							
22							
23							
24				170	130		
25		93	174	976	746	92	
26	63	766	1513	6075	4278	764	
27	89	1689	2387	10170	5279	1133	
28	10671	12070	13590	25141	18781	11625	
29	72	1445	1912	7493	5234	725	
30		78	1893	11796	2109	266	
31			707	3601	1157	56	
32	2759	2502	2487	2515	2555	2284	
33							
34							
35							
36				61	86		
37				414	866	67	
38			70	936	1897	131	
39			323	4205	7145	923	
40	1030	1086	1329	3267	3877	1397	
41			526	4082	3123	432	
42			765	6443	2305	232	
43		51	372	2935	4922	369	
44	144	174	1498	9622	2516	363	
45			136	916	435	43	
46			51	74	49		
47				41	162		
48							
49		117	60	198	156		
50			69	972	1564	136	
51		46	101	989	1554	164	
52			65	893	608	75	
53			45	588	1062	102	
54			58	481	193		
55			41	643	1359	107	
56			264	2204	607	54	
57			62	682	533	48	
58			1111	7120	735	55	
59			46	571	58		
60				40	40		
61				44	140		
62				85	293		
63				180	850	63	
64		436	126	317	165		
65				610	2227	127	
66		106	63	752	2578	88	
67				273	239		
68				155	111		
69				80	62		
70				303	195		
71				141			
72			173	1699	146		
73			79	646	66		
74				55	115		
75					70		
76							
77				181	794	112	
78				137	141		
79				251	370	68	
80				126	130		
81				63			
82				49	40		
83							
84				158			
85							
86			195	614			
87				83			
88							
89					50		
90							
91				110	218	51	
92				61	43		
93				134	45		
94				505	1763	47	
95					47		
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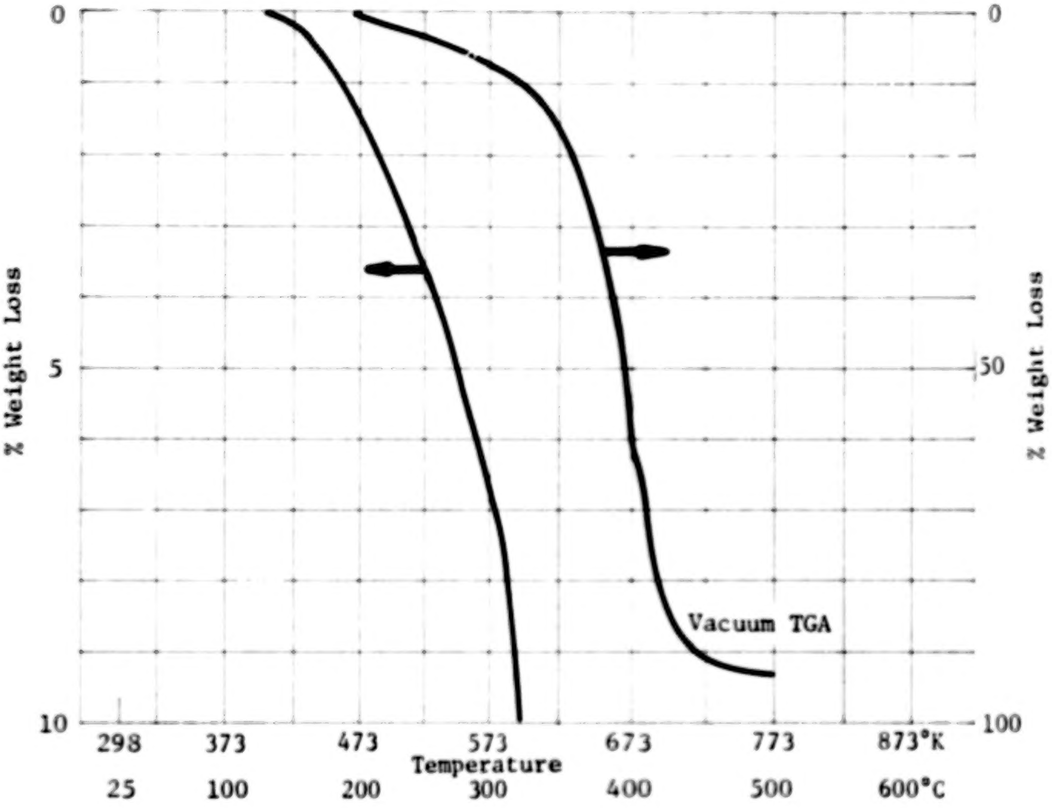
Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 13.5 pbw Activator**
Cure: **4 hrs. at 366°K (93°C), 20 hrs. at 425°K (152°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-723°K (450°C)**

a_o = **89.6%** of initial weight

$$k = 2.79\times10^{9} \exp\left(\frac{-30700}{1.98\ T^{\circ}K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.4×10^{11}	
373°K (100°C)	2.3×10^{8}	
423°K (150°C)	1.7×10^{6}	

Number and Relative Peak Intensity

Temperature, °K (°C) Bacon FA13/BA39

m/e	298 (75)	473 (200)	573 (300)	673 (400)	823 (550)		
14	427	488	620	3801	807		
15	93	254	1003	11501	2091		
16	1439	1491	1360	4715	3161		
17	8105	6561	5611	11388	5389		
18	28997	23435	21815	41786	10541		
19		79		376	50		
20		68	61	293	54		
21							
22							
23							
24				672			
25			135	4046	176		
26	79	93	1509	17628	1926		
27	336	297	1896	32742	2242		
28	17605	16143	21726	62718	22158		
29	94	158	2585	29938	1809		
30	69	129	684	6775	490		
31	66	40	455	11737	283		
32	4706	4133	3996	4674	3744		
33				74			
34							
35							
36			65	1201			
37			421	8390	149		
38			878	14205	303		
39			3290	46782	1708		
40	1485	1490	1999	15870	1947		
41			850	14545	696		
42			1668	12452	492		
43			2267	48984	1635		
44	258	562	1941	17911	1144		
45			130	5078	105		
46				333			
47				1522			
48				235			
49			83	2235	41		
50		183	777	9173	329		
51			413	9143	556		
52		52	239	3564	153		
53			1399	11819	292		
54			167	2639			
55			236	8052	209		
56			96	2855	113		
57			120	5718	64		
58			743	3473	66		
59			88	999			
60				782			
61				1831			
62				2752	40		
63				5632	233		
64				1664			
65				14485	417		
66			55	18225	383		
67			67	2508	44		
68			45	1169			
69			83	942			
70			52	258			
71				180			
72				708			
73				383			
74				2316			
75				665			
76				371			
77				4622	324		
78				1278	96		
79				2424	99		
80				626			
81			921	4396			
82			718	4724	52		
83				230			
84			47	183			
85				211			
86				204			
87				324			
88							
89				452			
90				299			
91				2947	568		
92				332	100		
93				1006			
94			58	23319	466		
95			580	4868			
96			489	3033			
97				190			
98			55	103			
99							
100							
101				43			
102				57			
103				567			
104							
105				245			
106							
107				1978	59		
108				758			
109				40			
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115							
116				85			
117							
[illegible]							
[illegible]							
120				406			
121				59			
122				1370			
123				107			
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

Bacon FA13/BA39

m/e	298 (25)	473 (200)	573 (300)	673 (400)	823 (550)		
128							
129							
130							
131							
132				53			
133							
134							
135				117			
136							
137				44			
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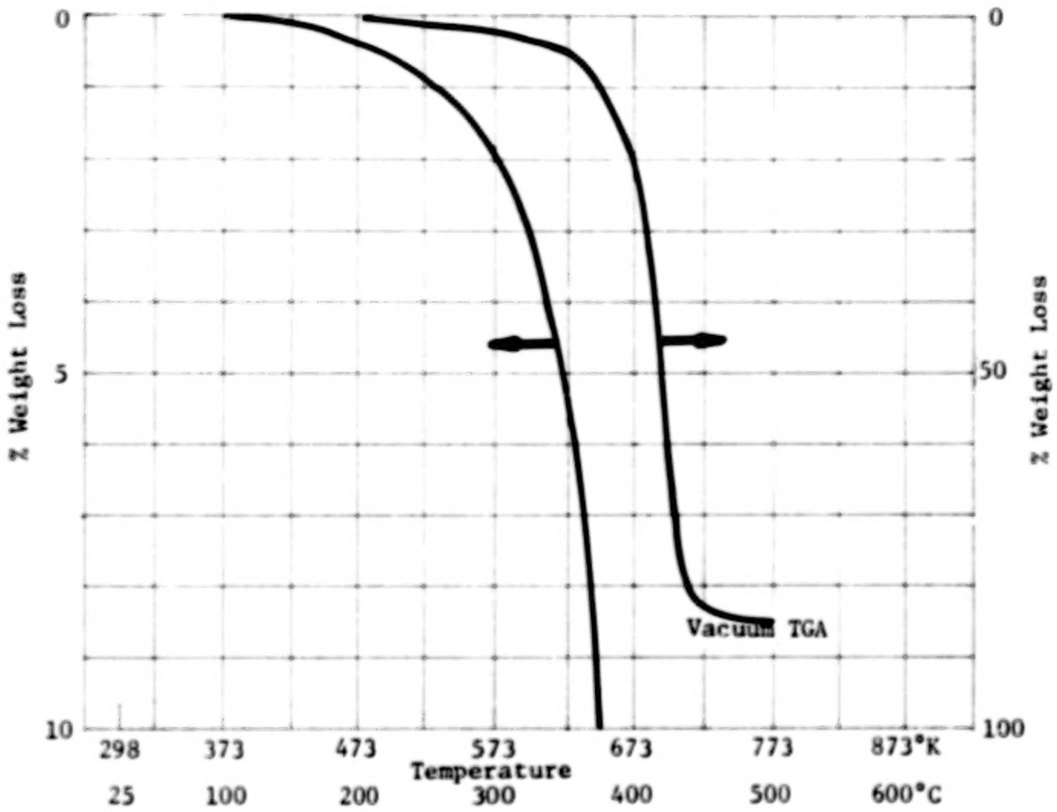
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **15 min. at 339°K (66°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **408°K (135°C)-773°K (500°C)**

a_o = **90.2%** of initial weight

$$k = 1.93\text{x}10^{5} \exp\left(\frac{-20200}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**1.6×10^{8}**	
373°K (100°C)	**2.3×10^{6}**	
423°K (150°C)	**9.2×10^{4}**	

Number and Relative Peak Intensity

Temperature, °K (°C) BC-326A/BC-326C

m/e	298 (25)	573 (300)	623 (350)	673 (400)	723 (450)	773 (500)	
14	2527	2651	4045	14603	10890	2681	
15	663	1822	5602	34831	26700	2912	
16	3320	3309	4060	15030	15720	5367	
17	12957	8972	9555	10084	9000	7538	
18	47092	32075	33307	35364	35610	25356	
19	174			216		294	
20	212	167	216	340		220	
21							
22				319			
23							
24			62	1302			
25		100	659	5062	2950	388	
26	259	1134	3101	15456	12720	2653	
27							
28	38989	36419	58506	88350	115960	43060	
29	988	3672	13795	77016	61111	2647	
30				1844		298	
31							
32	9605	8215	8181	7349	5335	6805	
33		792	562				
34							
35							
36						44	
37				301		336	
38					470		
39					1930	2322	
40	2625	2281	2731	5074	332	2557	
41		105				286	
42						217	
43							
44	540	3292	10894	100000	106210	8691	
45			143	1678	900	118	
46				154		195	
47							
48							
49						139	
50			68	1418		1802	
51			75	1485	6480	2216	
52			45	262	460	859	
53			41	166		194	
54				46			
55			53	258		81	
56			139	325			
57				55			
58				40			
59							
60							
61						94	
62				48		129	
63				116		542	
64			48	95			
65			167	403		759	
66			134	500		522	
67							
68				130			
69							
70				44			
71				47			
72							
73							
74				132		222	
75				44		69	
76							
77				1931	8870	2140	
78				577	1640	2308	
79				58		242	
80				68			
81							
82							
83							
84							
85							
86							
87							
88							
89						44	
90							
91				136		85	
92						1609	
93						539	
94			245	428		673	
95							
96							
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101							
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103							
104							
105				54			
106				1595	6530	958	
107				97		80	
108				41		700	
109						276	
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123				304	1990	296	
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126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) BC-326A/BC-326C

m/e	298 (25)	573 (300)	623 (350)	673 (400)	773 (450)	773 (500)	
128							
129							
130	76	56	60	213		53	
131							
132	103	42	42	224		54	
133	94	51	67	210		106	
134							
135				61			
136							
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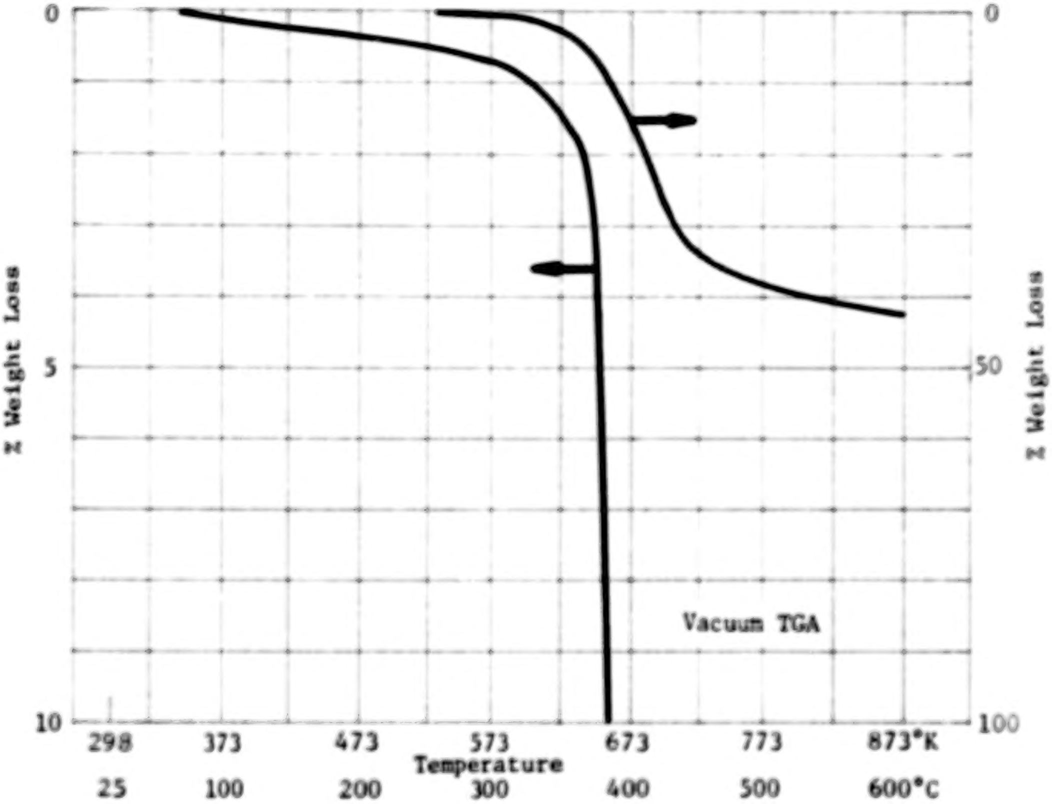
Chemical Characterization Summary

Mix Ratio: **1 pbw resin to 1 pbw activator**
Cure: **4 hrs. at 394°K (121°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **573°K (300°C)-773°K (500°C)**

a_0 = **49.6%** of initial weight

$$k = 5.9\times10^{5}\ \exp\left(\frac{-22600}{1.98\ T°K}\right)\ \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**2.3×10^{9}**	
373°K (100°C)	**2.0×10^{7}**	
423°K (150°C)	**5.4×10^{5}**	

Number and Relative Peak Intensity

Temperature, °K (°C)

BLR-SPF 500

m/e	298 (25)	573 (300)	673 (400)	773 (500)	873 (600)		
14	1260	3609	5402	2604	4206		
15	277	399	9769	3613	10716		
16	3781	3841	14053	9687	16052		
17	16152	16107	51060	16115	19228		
18	57067	53332	100580	55496	57887		
19	122	142	550	134	144		
20	299	302	975	419	440		
21							
22			571	195	57		
23							
24		51	1096	242	211		
25	46	252	3678	1019	868		
26	223	1337	16576	4602	4471		
27	513	2132	23914	5056	6196		
28	21781	23271	97625	52703	56711		
29	331	1323	23795	2640	2072		
30	896	981	4753	1856	1723		
31		122	5051	363	276		
32	4831	4559	5721	4690	4717		
33			104		55		
34			96				
35			64				
36		44	969	191	219		
37		58	4594	1405	1452		
38		95	7314	2690	2624		
39	115	196	20094	7963	7661		
40	3520	3560	14663	7952	8003		
41	76	134	9166	1256	794		
42	42	96	7683	827	472		
43	101	241	21638	1717	930		
44	639	2765	93454	31070	12086		
45		55	3636	665	691		
46			769	267	254		
47			902	336	277		
48			209	101	88		
49			1297	673	759		
50		44	5336	3634	4185		
51		44	4540	4166	4497		
52			1731	1952	2361		
53		70	3191	1855	1098		
54			768	376	219		
55		430	5530	1213	909		
56		567	3775	128	101		
57		46	2774	53	77		
58			3980	99	53		
59			299	51			
60			841	176	129		
61			962	593	497		
62			1707	1142	1061		
63			3425	2221	2154		
64		58	1001	527	533		
65			6295	3314	3262		
66			8189	3710	2951		
67			934	270	215		
68			532	152	94		
69			254	55			
70			148				
71			104				
72			245	55			
73			340	176	166		
74			1294	634	589		
75			592	339	280		
76			1384	402	491		
77			3099	3277	2264		
78			1276	3061	5142		
79			1854	1708	1118		
80			595	498	258		
81			268	122	51		
82			103				
83			62		40		
84			82				
85			99	40	42		
86			124	48	79		
87			117	64	52		
88			56				
89			614	530	369		
90			741	660	412		
91			1055	2399	4567		
92			256	785	1364		
93			502	269	234		
94			10057	4261	3251		
95			688	255	202		
96			134				
97			44				
98			51				
99			40				
100			54				
101			44				
102			101	75			
103			318	173	113		
104			584	118	68		
105			207	341	210		
106			41	272	208		
107			2240	2194	942		
108			1638	1522	753		
109			119	84	51		
110			48				
111							
112			45				
113							
114			43				
115			129	109	40		
116				40			
117			58	43			
118			181	78	49		
119			129	60			
120			80	67			
121			384	379	51		
122			202	303	61		
123			58				
124							
125							
126							
127			40				

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) RLH-CPF 500

m/e	298(25)	573 (300)	673(400)	773 (500)	873(600)		
128			47		71		
129			52				
130			53				
131			455	270	47		
132			230	154	43		
133			86				
134			158				
135			62				
136			99	42			
137							
138							
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145				148			
146			93	100			
147							
148			63				
149			41				
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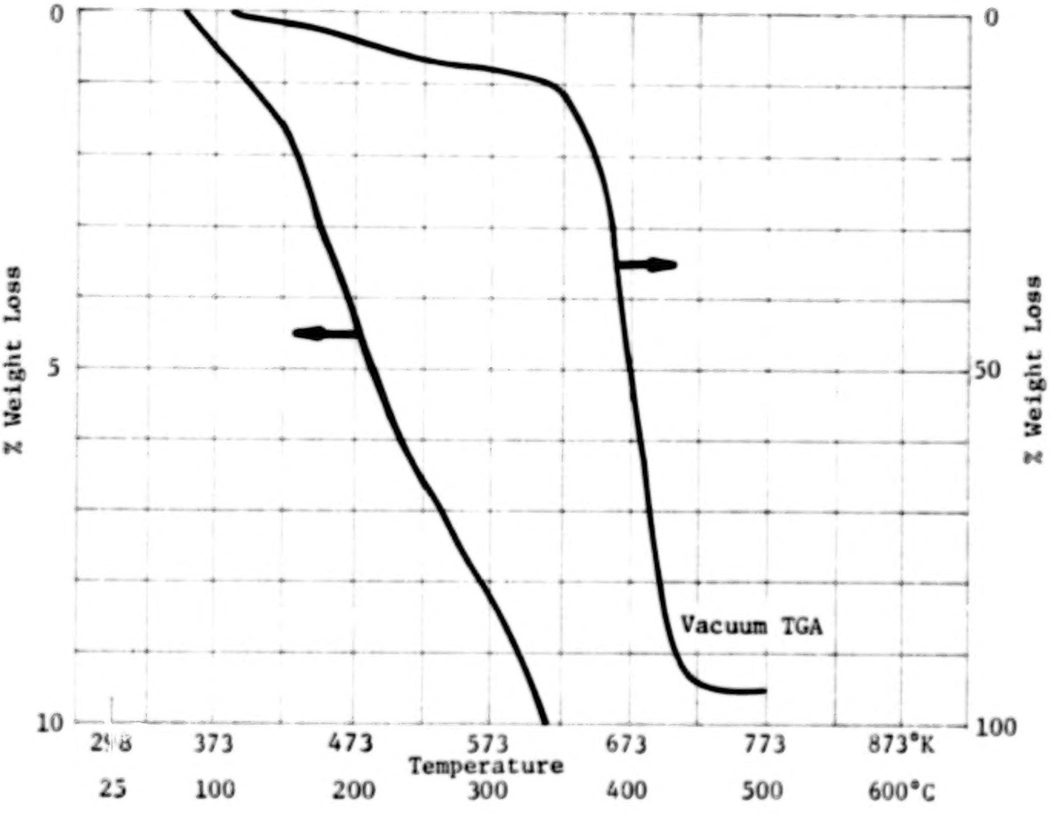
Chemical Characterization Summary

Mix Ratio: **10 pbw resin to 3 pbw activator**
Cure: **6 hrs. at 408°K (135°C), 54 hrs. at 396°K (123°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **543°K (270°C) - 723°K (450°C)**

a_o = **90.2%** of initial weight

$$k = 1.1 \times 10^{12} \exp\left(\frac{-38{,}900}{1.98\ T^{\circ}K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.6×10^{14}	
373°K (100°C)	4.5×10^{10}	
423°K (150°C)	8.8×10^{7}	

Number and Relative Peak Intensity

Temperature, °K (°C) Bondmaster E645

m/e	298 (25)	423 (150)	523 (250)	623 (350)	673 (400)	823 (550)	
14	1964	5011	2943	2952	6150	3269	
15	661	24686	7802	5680	16935	5679	
16	4343	5576	8556	13989	14769	7842	
17	18259	17432	20104	27999	29290	14909	
18	66916	58810	50685	69563	94018	48574	
19	3254	5334	3179	2698	1947	919	
20	991	934	908	1304	1556	972	
21							
22				208	357		
23							
24		57			397	73	
25		439	105	317	2370	458	
26	206	3849	1343	2657	13838	2985	
27	719	10074	3296	5714	27344	5962	
28	39883	52021	41199	52685	82158	45941	
29	572	42394	12355	5831	31615	5903	
30	821	5926	2541	4344	10773	2532	
31	104	28244	7662	1780	10099	1252	
32	7960	8316	7646	7222	8471	7099	
33		1077	268		382		
34					43		
35				73			
36				221	1343	118	
37		104		1055	11459	942	
38		53		2354	22707	1922	
39	73	248	143	7262	72026	7402	
40	4570	5025	4654	8707	34999	7229	
41	98	876	405	3522	18193	2934	
42	47	3883	1327	7862	21724	2267	
43	121	20464	6322	5796	28804	4440	
44	1321	5501	3037	48223	73197	5041	
45		100681	33613	3849	9472	1248	
46		4034	1115	254	1588	103	
47		10671	2628	562	5960	287	
48		180		57	359		
49				464	3166	182	
50				3454	17153	2002	
51				2286	20374	3159	
52				2314	7861	1052	
53				1497	14443	1603	
54				1228	4889	452	
55		68		2055	20190	1925	
56		63		2122	7160	705	
57		229	60	1293	9455	751	
58		9936	2629	2204	5418	667	
59		583	159	987	3104	371	
60		149		361	2512	130	
61		161		463	5563	463	
62				680	9779	1047	
63				1344	18550	2311	
64				700	6444	585	
65				4178	51483	4385	
66				6153	68191	4445	
67				1272	7828	555	
68				1002	5541	351	
69				405	2115	127	
70				271	1807	69	
71				258	1043	43	
72				84	779	45	
73		445	80	181	1889	87	
74		56		339	5742	592	
75		263	46	176	3204	454	
76		7775	1831	248	2544	334	
77		264	72	679	15490	3744	
78		61	47	880	5773	1386	
79				1664	10311	1678	
80				1012	6995	435	
81				610	3837	203	
82				340	1593	65	
83				114	995	47	
84				138	873		
85				102	616	55	
86					533	59	
87					580	123	
88		59			163		
89				113	3931	747	
90				48	3029	544	
91		78		570	16653	4943	
92				753	3606	1004	
93				2150	7891	686	
94				12940	100690	8404	
95				1305	13211	866	
96				14[illegible]	1174	51	
97				15[illegible]	412		
98					260		
99					188		
100					199		
101					487		
102					870	192	
103				78	3489	1022	
104				51	1061	282	
105				175	3760	1237	
106				433	1826	665	
107				1007	17932	4201	
108				1568	8402	1667	
109				425	2240	103	
110				62	342		
111				62	468		
112					82		
113					67		
114					71		
115				65	2762	679	
116					700	156	
117				49	1447	437	
118				151	2023	423	
119				275	13462	2074	
120				143	3492	731	
121				279	9814	2989	
122				370	2707	600	
123				135	678		
124					81		
125					130		
126							
127					111		

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Bondmaster 8645

m/e	296 (25)	423 (150)	523 (250)	623 (350)	673 (400)	823 (550)	
128					349	127	
129					313	89	
130					161		
131				210	2818	1101	
132				142	1416	538	
133				153	4101	657	
134				399	14285	1916	
135				766	9135	1408	
136				85	3319	659	
137					328		
138							
139							
140							
141							
142							
143					48		
144					101		
145					684	206	
146					336	90	
147					548	119	
148					527	51	
149					214		
150				64	1533	203	
151					102		
152							
153							
154							
155							
156							
157					87		
158					104		
159					327	47	
160					139		
161					239		
162					105		
163					91		
164							
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169							
170							
171					110		
172					199		
173					244		
174					125		
175					115		
176					63		
177					112		
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191					409		
192					49		
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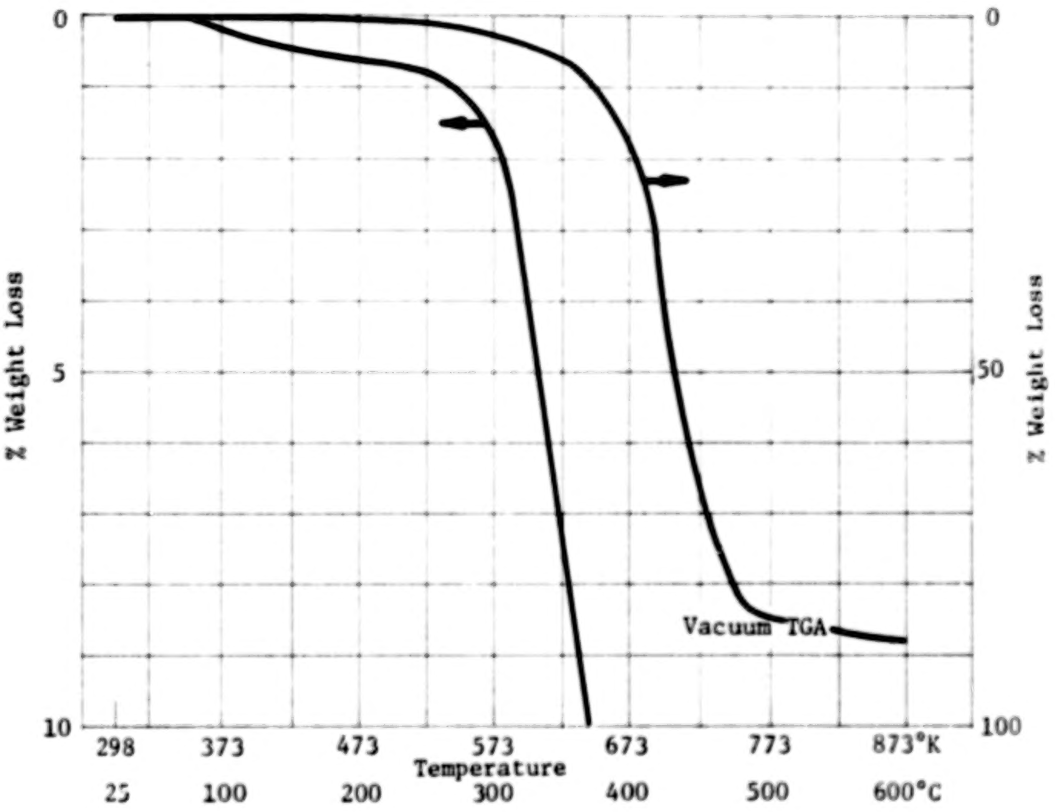
Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **6 hrs. at 449°K (176°C)**

1. TGA Preconditioning: **100 hrs. at 398°K (125°C)**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-623°K (350°C)**

a_o = **11%** of initial weight

$$k = 1.5\text{x}10^{13} \exp\left(\frac{-\ 38300}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**4.3×10^{12}**	
373°K (100°C)	**1.4×10^{9}**	
423°K (150°C)	**$2.8\text{x}\ 10^{6}$**	

Isothermal weight loss in nitrogen - 0.29%

Vacuum condensible degassing rate - 4.5×10^{-5} **%/day**

Number and Relative Peak Intensity

Temperature, °K (°C) C7-4248

m/e	298 (25)	423 (150)	548 (275)	698 (425)	798 (525)		
14	470	451	609	6085	1321		
15	76	67	239	16431	2854		
16	2480	2467	2605	8245	5368		
17	9872	9179	9288	16954	8268		
18	33845	30753	30650	57568	25659		
19				410			
20	50	48	54	318	92		
21							
22							
23							
24				367	51		
25			50	2619	216		
26			250	13795	1733		
27	101	106	557	21211	2166		
28	9803	9801	11739	49035	14027		
29		65	929	30455	1131		
30	523	577	665	6136	964		
31			51	7539	67		
32	3025	3067	3014	3974	2861		
33				143			
34							
35							
36				300			
37				3594	85		
38				6820	182		
39			73	24520	1264		
40	626	661	788	9704	1244		
41			81	16179	442		
42			67	10628	251		
43			137	29320	599		
44	244	296	740	17302	902		
45				4275	73		
46				252			
47				585			
48				69			
49				506	44		
50				3797	281		
51				4271	394		
52				1299	150		
53				2842	194		
54				509			
55				8107	151		
56				2633	91		
57				2796	93		
58			69	3280	64		
59				918			
60				286			
61				544			
62				1051	70		
63				2712	161		
64				601	45		
65				6404	247		
66				7545	85		
67				761			
68				318			
69				247			
70				148			
71				130			
72				239			
73				337			
74				587			
75				232			
76				182			
77				2765	347		
78				698	66		
79				967	124		
80				159			
81				85			
82				70			
83				57			
84				557			
85				101			
86				61			
87				196			
88							
89				160			
90				146			
91				1065	263		
92				132			
93				158			
94				7422	68		
95				291			
96							
97							
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102							
103				78			
104							
105				45	40		
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107				411	60		
108				116			
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TABLE 1 COMPRESSIVE STRENGTH (ASTM D695)

Exposure	Ultimate Stress $Pa \times 10^{-7}$ ($PSI \times 10^{-4}$) High	Low	Average	Samples Tested
Baseline	27.7 (40.2)	22.4 (32.4)	25.1 (36.4)	5
Heat Compatibility (1)	28.6 (41.4)	26.8 (38.9)	27.6 (40.0)	5
Heat Compatibility Plus 30 Day Thermal Vacuum (1) (2)	26.8 (38.8)	24.7 (35.8)	26.1 (37.8)	5

(1) Heat compatibility - 379 hours at 408°K (135°C) in N_2 atmosphere.

(2) Thermal vacuum - tested at 1×10^{-5} torr after 30 days at 338°K (65°C) and 1×10^{-6} torr.

TABLE 2 DIELECTRIC STRENGTH, DIELECTRIC CONSTANT AND DISSIPATION FACTOR (ASTM D149, D150)

Exposure	Dielectric Strength, Volts/MM (Volts/Mil)	Dielectric Constant K	Dissipation Factor D_x
Baseline	9.13×10^4 (2320)	3.1	.027
Heat Compatibility (1)	9.17×10^4 (2328)	3.1	.027
Heat Compatibility Plus 30 Day Thermal Vacuum (1) (2)	7.61×10^4 (1934)	3.0	.025

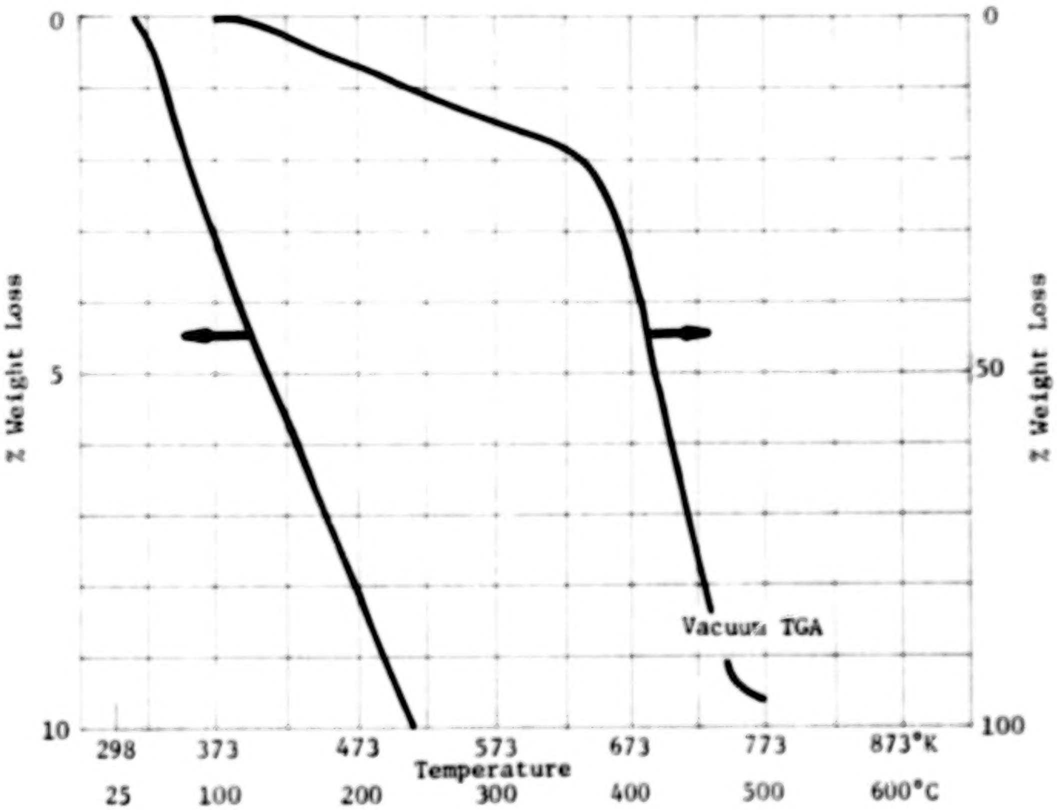
(1) Heat compatibility - 379 hours at 408°K (135°C) in N_2 atmosphere.

(2) Thermal vacuum - tested at 1×10^{-5} torr after 30 days at 338°K (65°C) and 1×10^{-6} torr.

Chemical Characterization Summary

Mix Ratio: **Pre-preg**
Cure: **1 hr. at 450°K (177°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C)- 773°K (500°C)**

a_o = **82.3%** of initial weight

$$k = 1.68\times10^{12}\exp\left(\frac{-40400}{1.98\ T°K}\right)\ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	9.8×10^{14}	
373°K (100°C)	2.1×10^{11}	
423°K (150°C)	3.2×10^{8}	

Number and Relative Peak Intensity

Temperature, °K (°C)   OMC-15 Bonding File

m/e	298 (25)	423 (150)	623 (350)	723 (450)	823 (550)		
14	2585	3126	4765	7076	3472		
15	453	3419	5849	11440	2600		
16	6606	6876	9089	11594	7016		
17	17520	16354	18568	17501	13621		
18	47219	43699	48862	46493	31266		
19	238	284	328	577	201		
20	122	139	170	188	101		
21							
22							
23							
24			249	677	79		
25		111	1056	2818	410		
26	179	872	3874	11048	1900		
27		1837	4810	11968	2543		
28	14284	20229	26802	66637	20351		
29	212	2965	10571	23691	2886		
30	1475	2794	4175	3906	2400		
31		683	4092	2368			
32	4712	5610	5852	5677	4709		
33				216			
34							
35			87				
36			170		62		
37		50	617	5899	639		
38			915	10776	860		
39			2209	29653	2443		
40	1273	1936	2608	11839	2223		
41	52			4254	819		
42		1795					
43	66	2219	7368	17895	1711		
44	864	3726	11566	7513	2019		
45		1560	1060	975	230		
46		65	81				
47		53	76	1331	61		
48			101				
49							
50		71	862	8690	994		
51		60	508	8612	974		
52			681		454		
53		48	344	4194	432		
54					66		
55		105	662	5796	436		
56		122	869	806	190		
57		240	582		129		
58		164	513	1985	160		
59		54	150				
60			102		40		
61			50				
62			102				
63			163	8189	738		
64			93				
65			367	20277	1131		
66			368	20002	891		
67			168	1880	109		
68			151	805	55		
69			72	158			
70			95	107			
71			91				
72			159	119	61		
73		777	69				
74			106	2505	222		
75				1408	126		
76		40					
77			129	6667	850		
78			135	3193	471		
79			159	3210	315		
80			150	791	85		
81			73	306	41		
82			61	73			
83			42	42			
84			40	69			
85				151			
86				265			
87				227			
88					50		
89				1594	220		
90							
91			59	4443	1043		
92			68	1124	242		
93							
94			980	20141	1206		
95			66	1947	73		
96				132			
97							
98				58			
99							
100				51			
101							
102							
103				1563	183		
104					87		
105				1195	293		
106							
107			54	5370	580		
108			92	2550	218		
109				261	63		
110				40			
111							
112							
113							
114							
115				1024	101		
116					65		
117				855	113		
118					135		
119				2011	148		
120							
121				4147	325		
122					62		
123				99			
124							
125							
126							
127				139			

Number and Relative Peak Intensity (Continued)

Temperature, ° K (°C) [illegible]-11 Bonding Film

m/e	298 (25)	423 (150)	623 (350)	723 (450)	823 (550)		
128				221	50		
129				157	42		
130							
131				2639	329		
132				1642	162		
133				1761	66		
134				1722	110		
135					53		
136				1077	55		
137				100			
138							
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142							
143				46			
144							
145				465			
146				318			
147				295			
148				347			
149							
150				222			
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156				44			
157				64			
158							
159				226			
160				109			
161				81			
162				80			
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172				96			
173				68			
174				86			
175				65			
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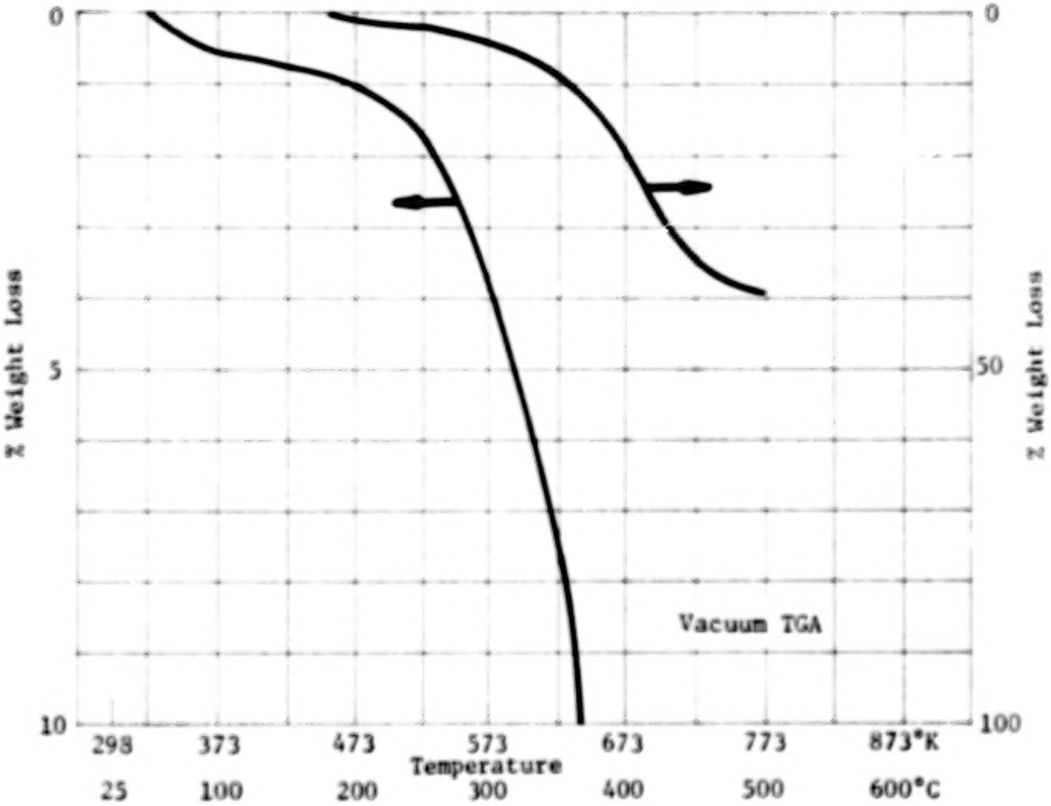
Coating G2735 on
Electromagnetic Core

Chemical Characterization Summary

Mix Ratio: **As Received**
Cure: **As Received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **473°K (200°C)-843°K (570°C)**

a_o = **43.0%** of initial weight

$$k = 5.1 \times 10^5 \exp\left(\frac{-20,100}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	5.3×10^7	
373°K (100°C)	7.8×10^5	
423°K (150°C)	3.1×10^4	

Number and Relative Peak Intensity

Temperature, °K (°C)

Coating [illegible] on Electromagnetic Core

m/e	298 (25)	523 (250)	623 (350)	673 (400)	773 (500)		
14	552	519	1376	1963	1067		
15	75	171	2983	5009	2558		
16	2285	2149	6262	7680	6362		
17	19854	15268	17791	18370	12078		
18	75809	58611	67515	69374	45093		
19			22	43			
20	77	52	86	81	37		
21							
22				30			
23							
24			69	157	37		
25		45	539	1124	277		
26	37	608	3865	6367	2605		
27	35	321	4103	6595	3675		
28	1144	12988	22176	25634	15731		
29	83	150	3028	4513	2221		
30	43	29	159	200	203		
31			75	219	22		
32	2971	2486	2347	2397	2110		
33				22			
34							
35							
36			32	68			
37		65	456	1416	218		
38		159	734	2864	533		
39		667	2798	9920	3540		
40	596	725	1537	4716	1670		
41		51	1420	3605	2995		
42			935	2325	1287		
43		69	2434	6892	1505		
44	227	2108	14685	15707	2061		
45			90	128			
46				47			
47				287			
48				30			
49		41	158	332	31		
50		854	2241	2728	484		
51		992	210	2557	587		
52		763	1957	1203	165		
53			156	1140	291		
54			44	239	70		
55			1124	3227	853		
56			877	1126	312		
57			194	551	171		
58			127	692	25		
59							
60				26			
61				203			
62				425	67		
63		58	176	1282	210		
64				171	30		
65			42	3610	479		
66			31	4739	304		
67			84	601	163		
68			33	241	25		
69			28	117	55		
70				146	52		
71				47			
72							
73				41			
74		31	89	153			
75			38	69			
76		29	65	59			
77		282	909	845	300		
78		2565	4841	1985	76		
79		31	132	228	109		
80				24			
81				31			
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84				43			
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91				85	106		
92							
93				25			
94					134		
95				2078			
96				50			
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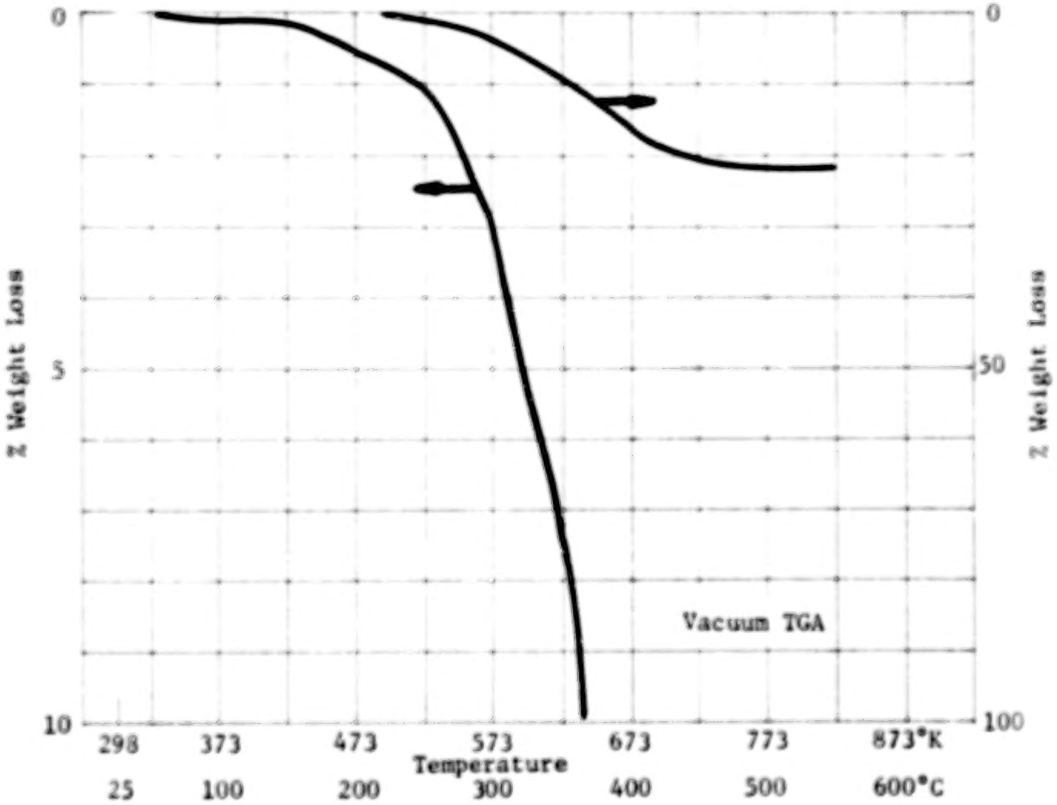
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **473°K (200°C)-843°K (570°C)**

a_o = **16.6%** of initial weight

$$k = 1.3\times10^{7} \quad \exp\left(\frac{-22300}{1.98\ T^{\circ}K}\right) \ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**6.5×10^{7}**	
373°K (100°C)	**6.1×10^{5}**	
423°K (150°C)	**1.7×10^{4}**	

Number and Relative Peak Intensity

Temperature, °K (°C)

Coating SR993-RG, on Electromagnetic Gate

m/e	298 (25)	573 (300)	623 (350)	673 (400)	773 (500)		
14	705	966	1569	889	737		
15	119	1632	2319	871	555		
16	2536	2299	2062	3015	2022		
17	21139	13732	12740	12086	11125		
18	60826	51569	46765	45202	40574		
19	62	117	209	64	55		
20	150	108	136	114	103		
21		40					
22			49				
23							
24		79	161	39	53		
25		222	792	197	128		
26	75	1482	3757	1317	793		
27	99	1396	3741	1061	1280		
28	11353	16511	24677	15460	11135		
29	101	3326	7763	2361	992		
30	42	369	962	235	136		
31		1000	2679	409	96		
32	2961	2720	2621	2266	2226		
33		96	317	52	42		
34				42	46		
35							
36		76	185	62	49		
37		234	2436	332	103		
38		275	3053	560	143		
39		301	1775	1238	670		
40	988	786	1185	889	725		
41		336	1359	1536	979		
42		287	900	586	353		
43	66	914	2572	1186	522		
44	248	2633	6519	1050	687		
45		488	1515	127	52		
46		46	63	49			
47		42	41				
48		44		42	42		
49		138		169	65		
50		1036		1629	197		
51		85		170	113		
52		90		123	77		
53		55		103	86		
54		40		77	88		
55		67		218	190		
56		61		216	177		
57		171		285	121		
58		283		98	66		
59		44					
60		49					
61		55		54	43		
62		43		67	43		
63				43	49		
64				61	68		
65				65	55		
66				54	53		
67				49	82		
68				60	52		
69				68	61		
70		43		125	56		
71				51			
72				44			
73		62		60			
74		170		225	60		
75		81		90	61		
76		932		1061	134		
77		63	76	51			
78			40	42			
79				40			
80							
81				46			
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83							
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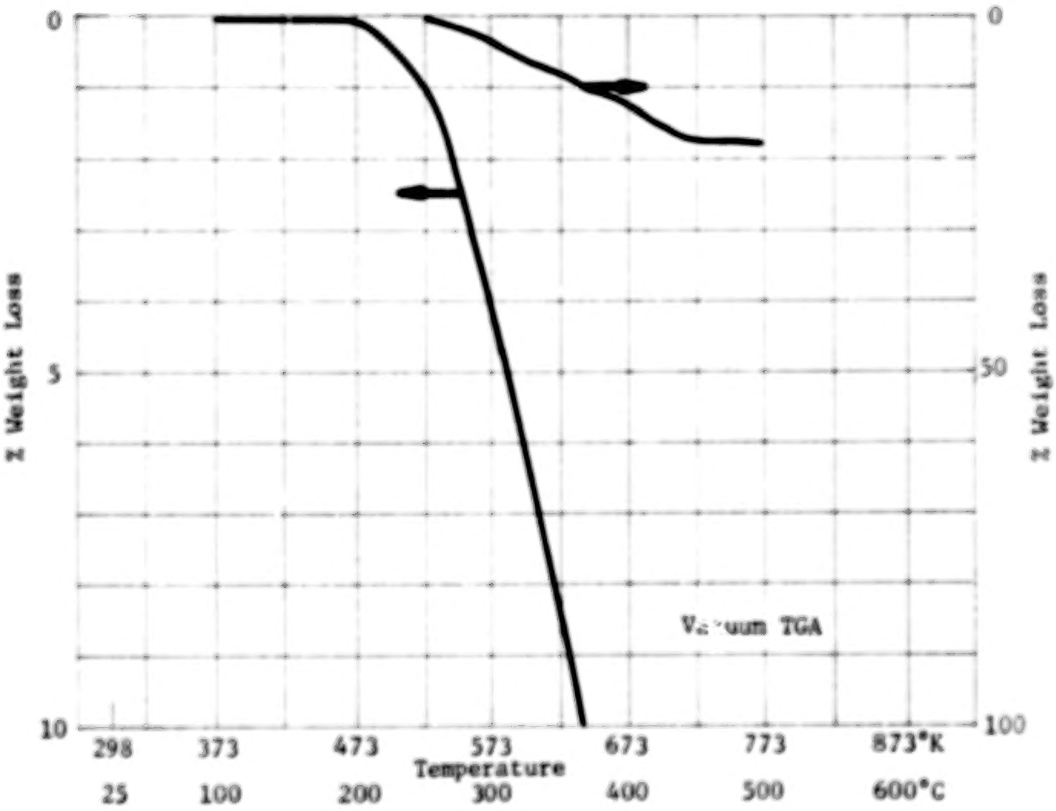
Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **1 hr. at 422°K (149°C), 24 hrs. at 411°K (138°C) in vacuum**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **473°K (200°C)-648°K (375°C)**

a_o = **9.6% of initial weight**

$$k = 6.2 \times 10^4 \exp\left(\frac{-14900}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C) 373°K (100°C) 423°K (150°C)	1.3×10^5 5.7×10^3 5.2×10^2	

Number and Relative Peak Intensity

Temperature, °K (°C)

Conductive Epoxy 550AA

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
14	637	807	942	1101	852		
15	319	341	941	1460	547		
16	2047	1787	1828	2007	1756		
17	8866	6805	6345	5964	5408		
18	30058	22366	20733	19360	17652		
19	84	83	100	105	76		
20	212	191	212	205	188		
21							
22							
23							
24			60	111	46		
25	64	58	164	317	115		
26	213	233	643	1329	492		
27	257	281	600	1129	516		
28	10051	9600	10543	12374	9592		
29	196	204	699	1833	416		
30	196	203	282	471	241		
31	61	71	2064	1109	129		
32	2372	7168		2427	1940		
33				41			
34							
35							
36			67	138	47		
37			279	813	123		
38		46	358	1020	193		
39	69	97	562	1297	527		
40	1348	1311	1468	1730	1450		
41	87	98	574	1209	255		
42	77	80	285	379	164		
43	92	128	1570	1218	284		
44	365	420	770	1498	488		
45	44	47	198	329	105		
46				42			
47							
48				71			
49			142	401	61		
50		75	853	2567	288		
51	43	42	180	423	205		
52			121	292	90		
53			95	225	115		
54		43	44	67	44		
55			104	313	132		
56			76	243	65		
57		48	128	363	76		
58		40	97	159	58		
59			52	95			
60				97	46		
61			62	155			
62			53	111	69		
63			72	161	118		
64	41			74	64		
65		46	117	282	228		
66	48	49	150	358	247		
67			49	73	62		
68			41	61	41		
69			199	412			
70			45	63			
71							
72			42	63			
73			90	245			
74			316	803	85		
75			156	471	60		
76		54	897	2889	168		
77		40	220	531	199		
78			62	105	86		
79			44	73	79		
80							
81							
82				53			
83							
84	68	68	78	77	69		
85				49			
86				44	40		
87							
88							
89					41		
90							
91			50	84	140		
92					50		
93				40			
94			276	650	320		
95			53	90	46		
96							
97							
98							
99				46			
100			61	118			
101							
102							
103							
104		44	601	1902	115		
105			74	191	54		
106							
107			40	66	103		
108					49		
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119					50		
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Conductive Epoxy 550kA

m/e	298 (25)	423 (150)	523 (250)	623 (350)	773 (450)		
128							
129	62	76	69	57	68		
130							
131	55	54	57	50	64		
132	56	59	64	63	62		
133							
134					53		
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148			49	124			
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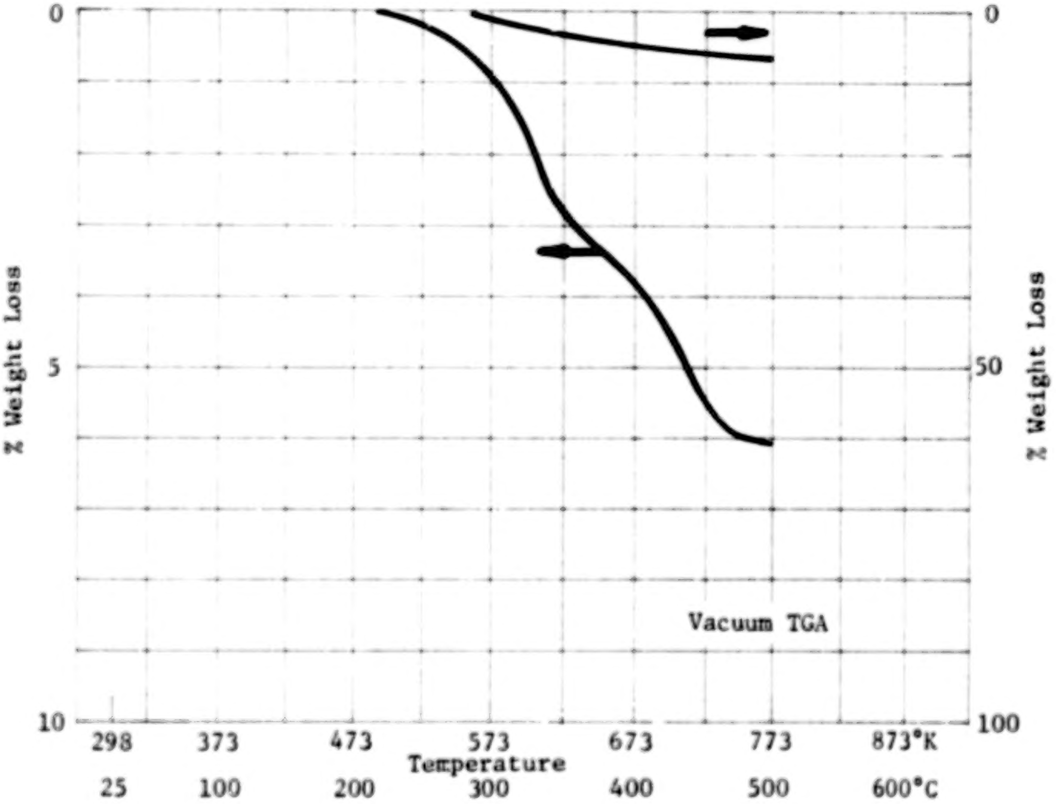
Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **1 hr. at 394°K (121°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **473°K (200°C)-748°K (475°C)**

a_o = **3.31%** of initial weight

$$k = 3.5\times10^{6} \ \exp\left(\frac{-19600}{1.98\ T°K}\right)\ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**3.5×10^{6}**	
373°K (100°C)	**5.8×10^{4}**	
423°K (150°C)	**2.5×10^{3}**	

Number and Relative Peak Intensity

Temperature, °K (°C) Conductive Epoxy 929A

m/e	298 (25)	473 (200)	573 (400)	673(400)	773(500)		
14	1042	937	1010	1087	967		
15	415	408	606	721	558		
16	3681	3252	3172	3197	3095		
17	13213	9603	9003	8316	7732		
18	41681	28384	26386	23865	21881		
19	115	115	111	123	111		
20	281	237	249	246	229		
21							
22							
23							
24				44			
25			110	135	62		
26	192	205	526	574	317		
27	392	407	696	728	522		
28	10599	9731	10285	10598	9616		
29	179	171	431	696	266		
30	766	750	793	674	784		
31		42	112	148	59		
32	3153	2804	4718	2670	2607		
33							
34							
35							
36			54	72	44		
37			171	200	48		
38			215	301	87		
39		56	271	697	240		
40	1789	1731	1823	1991	1773		
41	58	61	181	228	119		
42	47	44	138	177	77		
43	65	76	433	571	137		
44	614	628	1092	885	614		
45			75	92	47		
46							
47				54			
48							
49			91	92			
50			503	410	97		
51			96	231	104		
52			72	90	45		
53			57	119	40		
54							
55			79	170	49		
56			97	75			
57			81	69			
58				70			
59							
60							
61			48	70			
62				88			
63			50	150	55		
64			44	63			
65			70	367	89		
66			96	435	90		
67				59			
68							
69							
70							
71							
72							
73			56	43			
74			163	122			
75			91	69			
76			520	285	46		
77			120	174	85		
78				72	49		
79				61	40		
80							
81							
82							
83							
84	41	43	44	47	46		
85							
86							
87							
88							
89							
90							
91				95	61		
92							
93							
94			136	607	88		
95				56	42		
96							
97							
98							
99							
100							
101							
102							
103							
104			327	177			
105							
106							
107				61			
108							
109							
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121				43			
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

Conductive Gauge 829

m/e	298 (25)			673 (400)			
128							
129	<1			<1			
130							
131							
132							
133							
134							
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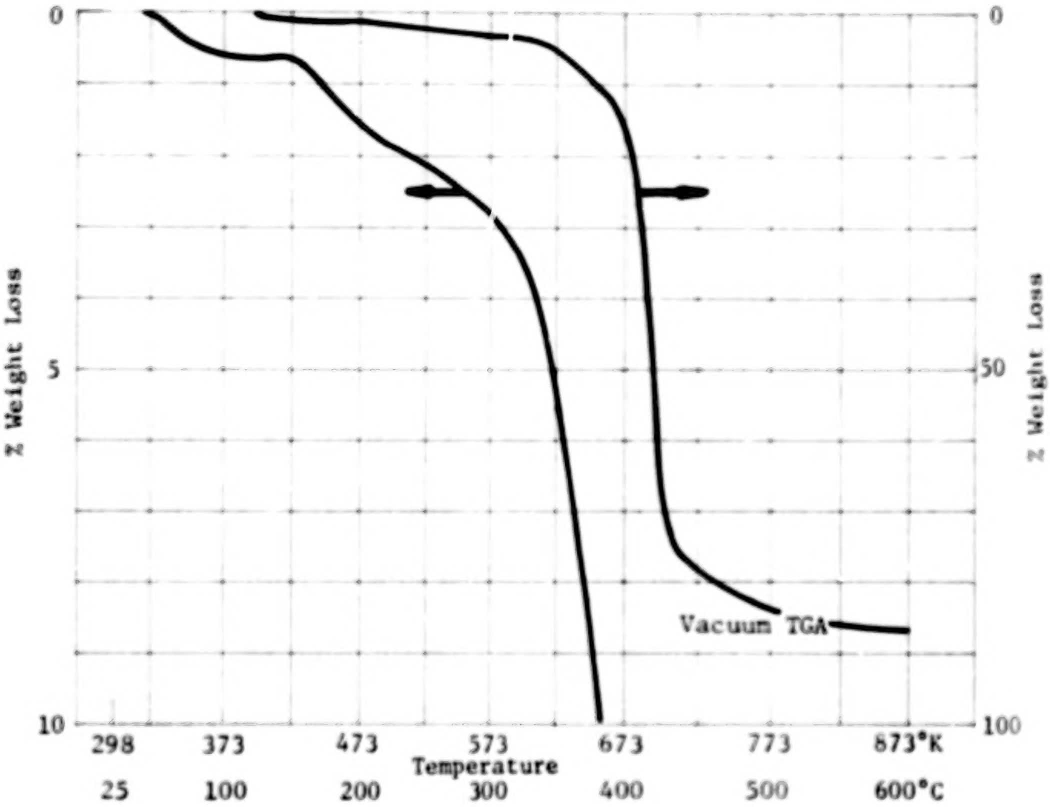
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-773°K (500°C)**

a_o = **7.9%** of initial weight

$$k = 1.10\times10^{7} \exp\left(\frac{-25700}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**1.6×10^{10}**	
373°K (100°C)	**7.4×10^{7}**	
423°K (150°C)	**1.2×10^{6}**	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible] Insulating Film

m/e	298 (25)	423 (150)	573 (300)	673(400)	773(500)	823 (550)	
14	1509	1622	2227	6983	3857	3796	
15	1297	1150	2108	11559	6170	8853	
16	7630	7520	9625	19723	11629	14600	
17	28805	25768	28761	43589	25885	25562	
18	97870	86136	83903	100463	86156	82619	
19	615	570	658	910	507	323	
20	682	744	739	1072	890	828	
21							
22				319			
23							
24				928	289	326	
25	46	47	46	4038	1185	1236	
26	491	553	1165	19518	6766	6839	
27	1120	1359	2223	24737	9840	9991	
28	28694	28062	30937	76544	45667	47625	
29	1022	1311	2721	22763	7920	7358	
30	1514	1623	1983	6736	3267	3324	
31	842	903	1815	10696	3500	3363	
32	7063	6738	7000	6677	8060	7844	
33				341	44		
34				49			
35							
36				1655	242	188	
37			68	12556	1724	1280	
38	50	51	212	23131	3619	2563	
39	222	226	721	64290	12224	8891	
40	8124	9445	9637	38210	13650	12323	
41	183	324	628	11047	7549	2930	
42	106	166	950	13758	2163	1867	
43	226	418	1956	36023	4615	4303	
44	1307	1523	8504	95026	3922	3650	
45	54	83	219	2859	485	403	
46				1164	163	112	
47				5129	298	200	
48				507	48		
49				3913	555	476	
50		46	160	16243	3792	2803	
51			144	18617	5214	4004	
52			112	6325	1085	1425	
53			71	10077	2509	1823	
54			123	2765	497	307	
55		62	192	13959	2258	1636	
56	40	66	126	3321	509	466	
57		66	70	6306	391	401	
58				3239	424	462	
59				710	159	103	
60				1141	203	145	
61				4332	646	472	
62				7067	1366	976	
63				13173	3214	2453	
64				4792	1068	676	
65			99	35966	5428	4077	
66			210	50048	4885	3053	
67			50	5122	586	342	
68			71	3624	213	151	
69			46	631	60	60	
70				448	46		
71				295			
72				308	60		
73				1021	164	58	
74				3385	692	529	
75				1866	511	334	
76				1471	443	326	
77				5714	4224	2916	
78				2772	1392	1279	
79				4655	1887	1321	
80				3241	337	294	
81				1473	137	69	
82				461			
83				219			
84				127			
85				226	48		
86				142	82		
87				127	126	79	
88				128			
89				75	669	437	
90				1327	536	338	
91				4518	3739	3656	
92				1319	595	785	
93					500	326	
94			205	68410	5420	3692	
95				5328	312	294	
96				325			
97				55			
98				44			
99							
100							
101				57	45		
102				208	185	109	
103				735	879	473	
104				178	271	126	
105				882	1154	925	
106				415	293	434	
107				3310	2677	1982	
108				2024	1101	846	
109				410	58		
110				67			
111							
112							
113							
114							
115				523	428	206	
116				45	105	57	
117				205	307	123	
118				486	280	125	
119				2227	1195	669	
120				493	380	229	
121				1266	1429	927	
122				371	323	199	
123				67			
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible] Insulating Film

m/e				673 (400)	773 (500)	823 (550)	
128					55	40	
129				66			
130							
131				593	559	306	
132				365	330	136	
133				720	279	130	
134				2557	930	626	
135				41	170	70	
136				336	226	120	
137							
138							
139							
140							
141							
142							
143							
144							
145				65	107	77	
146				62	82	61	
147				60	56	61	
148				60			
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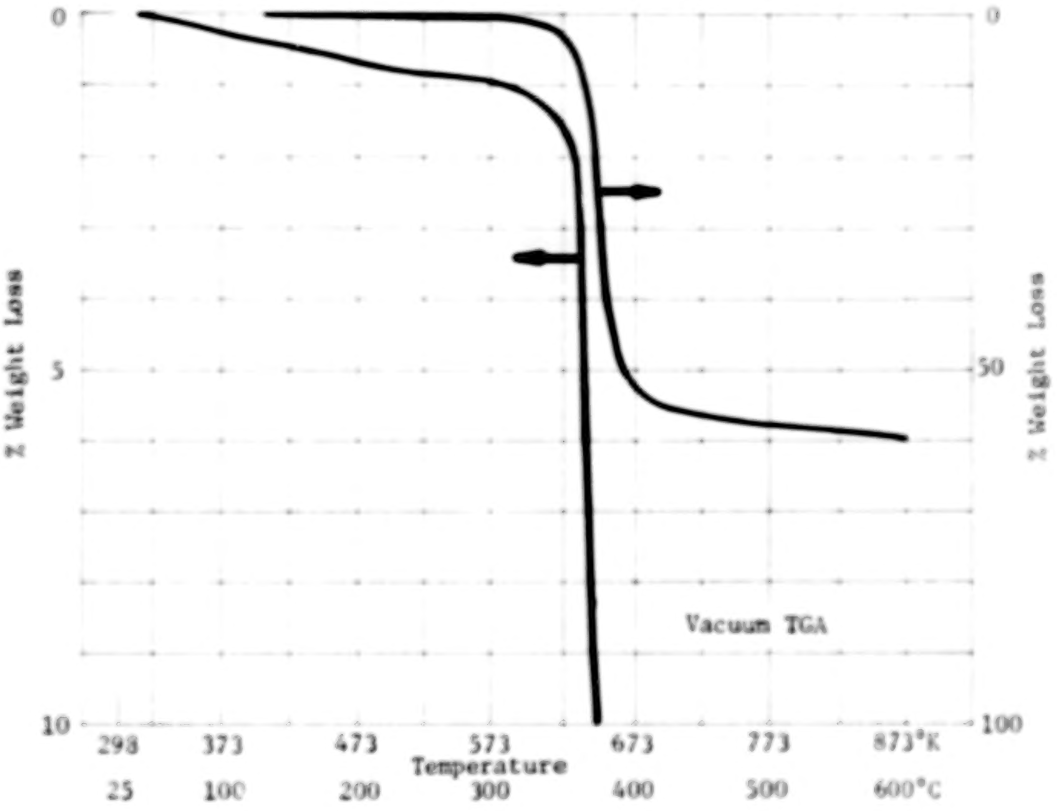
Chemical Characterization Summary

Mix Ratio: 100 pbw resin to 11 pbw activator
Cure: 30 min. at 389°K (116°C), 1½ hrs. at 450°K (177°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 623°K (350°C)-723°K (450°C)

a_o = 51.8% of initial weight

$$k = 5.5\times10^{27} \exp\left(\frac{-83000}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	2.7×10^{28}	
373°K (100°C)	7.4×10^{20}	
423°K (150°C)	1.2×10^{15}	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298(25)	473(200)	623(350)	648(375)	673(400)	773(500)	
14	1176	1095	2253	2956	1385	1303	
15	469	458	3763	5449	1767	1269	
16	3917	3629	5884	6305	3871	3864	
17	10277	9680	14271	14588	8353	7281	
18	30521	24298	44371	44548	22919	19236	
19	166	153	250	256	169	85	
20	226	196	266	284	213	186	
21							
22			55	51			
23							
24			238	500	152	51	
25			734	1735	502	176	
26	224	234	2764	7615	2415	677	
27	475	479	2577	7997	2945	1279	
28	10857	10118	17699	19086	11889	10626	
29	230	222	5216	7261	1676	660	
30	1062	1055	1403	1613	1061	1006	
31			1065	1187	283	71	
32	3276	3016	2983	2906	2563	2552	
33			44		50		
34							
35			76				
36			144	426	112		
37			676	3078	805	133	
38			1112	5792	1547	236	
39	67	106	3303	10150	5162	793	
40	1735	1729	2817	7738	2928	1682	
41	56	99	1058	2950	966	398	
42	48	65	1179	1970	526	216	
43	75	156	2538	3312	836	396	
44	866	865	8617	5765	1106	816	
45			409	598	268	53	
46			159	282	92		
47			252	1008	216		
48			70	191	67		
49			295	1096	109	57	
50			1225	4993	1579	259	
51			700	5404	1964	296	
52			627	1792	689	132	
53			605	2967	1056	169	
54			133	531	176	49	
55			676	3650	954	130	
56			191	687	106	47	
57			526	685	95		
58			327	342	87		
59			50	223	96		
60			86	637	186		
61			241	1267	357	43	
62			357	2276	700	91	
63			652	6559	1465	196	
64			252	1499	478	77	
65			1757	9813	2547	275	
66			2092	10589	2458	255	
67			196	1062	323	59	
68			128	469	133		
69			61	117	40		
70			49	59			
71							
72				20			
73			80	359	110		
74			213	1229	166	47	
75			95	782	279		
76			84	564	187		
77			289	4213	1887	292	
78			213	1350	773	119	
79			177	1752	774	136	
80			51	287	163	44	
81			47	187	83		
82			43	71			
83							
84			68	68	61		
85				62			
86				136	58		
87				144	60		
88				65			
89			87	797	332	56	
90			68	479	223		
91			141	3920	1501	220	
92			53	562	213	56	
93			171	796	303	93	
94			3785	14126	3048	243	
95			278	1579	242		
96				82			
97							
98				47			
99							
100							
101				109			
102				212	93		
103			63	911	359	40	
104				186	81		
105				658	269	65	
106				186	85	61	
107			82	1092	1119	210	
108			71	617	644	98	
109				58			
110							
111							
112							
113							
114							
115				379	170		
116				114	85		
117				185	82		
118			82	240	83		
119			56	2510	780	73	
120				479	176		
121			84	2617	1130	133	
122				631	292	42	
123							
124							
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126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	623 (350)	648 (375)	673 (400)	773 (500)	
128				41			
129		45	45	50	44		
130							
131			47	193	95	43	
132	40		47	136	66	41	
133				460	167		
134			41	2127	633	55	
135				296	143		
136				494	198		
137				47			
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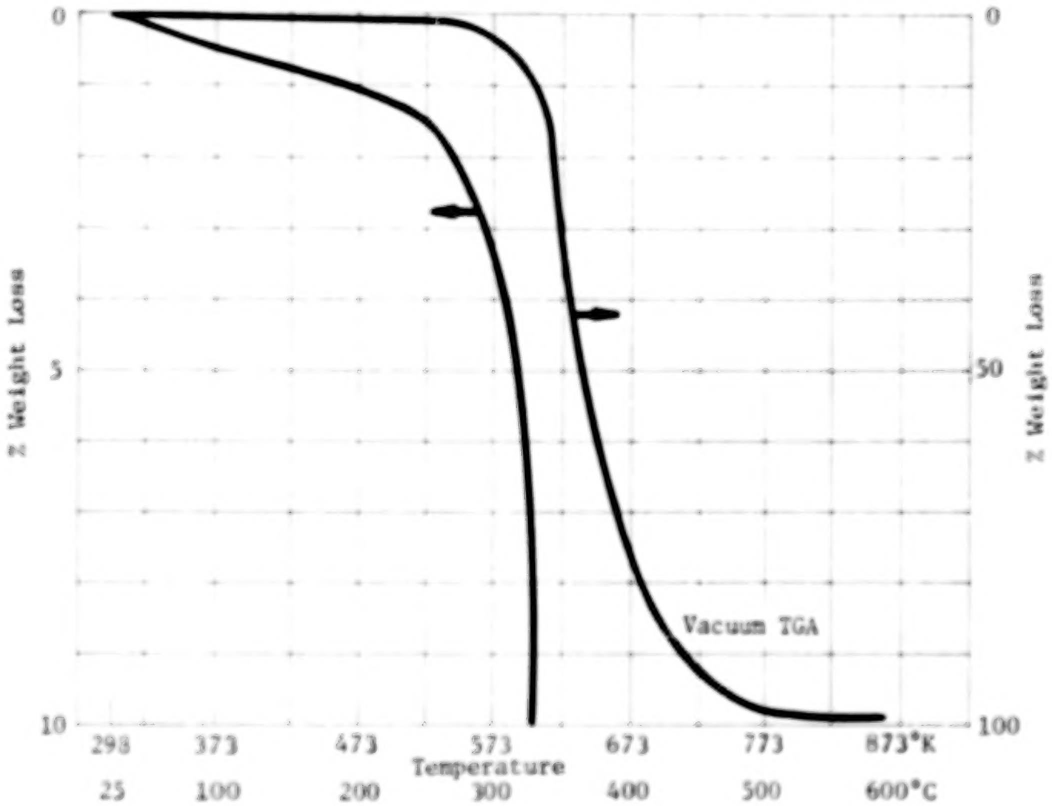
Chemical Characterization Summary

Mix Ratio: **100 pbw resin to 58 pbw activator**
Cure: **1 hr. at 366°K (93°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **298°K (25°C) - 673°K (400°C)**

a_o = **67%** of initial weight

$$k = 5.3\times10^{20} \exp\left(\frac{-58800}{1.98\ ^\circ K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	1.0×10^{19}	
373°K (100°C)	4.5×10^{13}	
423°K (150°C)	3.3×10^{9}	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	573 (300)	623 (350)	723 (450)	823 (550)	
14	672	718	1931	2971	1463	1166	
15	82	152	3388	7065	2950	2131	
16	2150	2210	11171	12736	5192	4732	
17	7232	8265	36457	28356	8083	6571	
18	23796	26619	100972	72040	21980	18838	
19	107	96	180	367	77	69	
20	161	226	455	401	276	217	
21							
22							
23							
24			122	260	53		
25			522	1266	697	101	
26	52	101	5509	10069	6114	867	
27	147	216	6501	13550	7721	1329	
28	16922	17710	30120	36206	25375	10727	
29	66	116	2906	6125	5130	399	
30	286	415	1586	6701	1758	471	
31	2596	2569	185	1733	101	53	
32			2739	3625	2059	2851	
33							
34							
35				63			
36			61	111	67		
37			257	891	262	57	
38			757	1963	736	121	
39			3313	7217	5364	125	
40	1365	1238	4112	5016	3067	1451	
41			2120	5523	7103	627	
42			3687	7140	2042	216	
43		59	2621	4177	5285	161	
44	194	762	7902	7372	1136	371	
45			176	985	65		
46				51			
47				96			
48				57			
49			111	310	96	67	
50			782	2390	776	96	
51			656	2083	1029	136	
52			1586	2170	431	79	
53			662	1907	1007	107	
54			265	909	334	50	
55			217	991	2525	126	
56			300	1900	1571	67	
57			181	729	1571		
58			270	697	108		
59			60	218			
60				72	80		
61				109	60		
62			44	170	101		
63			76	607	272	62	
64			117	330	77		
65			153	822	889	65	
66			365	1005	231	70	
67			1520	1299	584	66	
68			71	232	150		
69				119	399		
70				179	616		
71				123	219		
72				56	42		
73				80			
74				85	49		
75				57			
76				78			
77			51	352	661	68	
78			105	229	117	60	
79			144	255	656	61	
80			194	799	163		
81			124	180	202		
82				96	72		
83				65	81		
84				42	82		
85				55	56		
86							
87							
88							
89					56		
90				56			
91				70	127	63	
92				66			
93			66	79	67		
94			304	1033	128	69	
95			69	64	61		
96							
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107				69	89		
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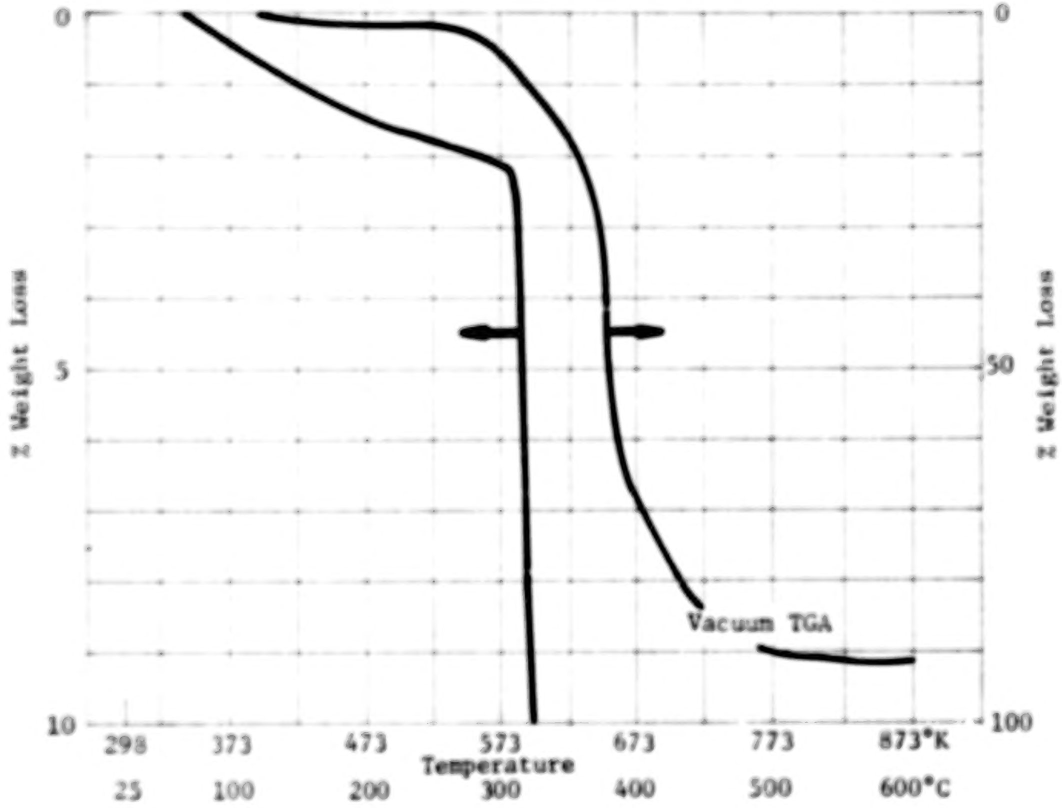
Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 19 pbw Activator**
Cure: **Room temperature**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C) - 823°K (550°C)**

a_o = **90.1%** of initial weight

$$k = 2.08 \times 10^{27} \exp\left(\frac{-80000}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	6.0 × 10^{26}	
373°K (100°C)	3.2 × 10^{19}	
423°K (150°C)	8.7 × 10^{13}	

Number and Relative Peak Intensity

Temperature, °K (°C)

8A9320

m/e	298 (25)	473 (200)	573 (300)	673 (400)	823 (550)		
14	504	910	986	1491	1307		
15	235	413	609	2862	1795		
16	1940	3003	3934	4181	4382		
17	8286	11354	14203	12732	9479		
18	27226	36351	43110	39982	29305		
19	129	160	147	367	153		
20	300	429	421	528	386		
21							
22							
23							
24			60	408	147		
25	42	68	229	1488	401		
26	241	435	1286	9476	2184		
27	732	1138	2024	14317	3894		
28	28283	34504	37013	49269	34868		
29	367	877	1667	9328	2012		
30	2671	2966	3402	5979	3532		
31	114	753	436	3186	417		
32	7947	8569	8469	8005	7303		
33				210			
34	45	68	61	71	58		
35							
36		52	84	464	113		
37		44	196	2939	299		
38	42	67	416	5904	582		
39	94	280	1154	[illegible]	2266		
40	5240	5933	6710	12682	6929		
41	118	295	854	10125	1469		
42	115	125	1128	6920	1112		
43	221	359	1650	6827	1147		
44	1655	2074	4318	7517	2726		
45	97	70	285	4020	443		
46			47	435	68		
47			42	881	58		
48				260	52		
49			140	1245	152		
50		95	508	7856	755		
51		131	427	12410	954		
52		109	486	5852	535		
53		61	336	6246	595		
54		231	333	2708	297		
55		56	240	4937	491		
56			250	2229	383		
57		48	194	1243	[illegible]		
58			319	1458	[illegible]		
59			78	784	115		
60			49	606	92		
61			45	1321	113		
62			60	2717	222		
63			114	5875	538		
64			138	1890	216		
65		45	197	9286	725		
66		75	262	7660	523		
67		68	449	3187	289		
68			103	1565	186		
69			40	777	100		
70			48	712	110		
71				431	73		
72			40	373	83		
73				774	83		
74			41	2036	187		
75				1647	138		
76			51	1467	135		
77		59	141	8913	833		
78		70	267	6601	441		
79		69	275	4859	479		
80		64	213	1894	205		
81			128	1372	157		
82				752	79		
83				339	53		
84				354	60		
85				267	50		
86				355	60		
87				393	57		
88				212			
89				1653	173		
90				1114	129		
91			94	9286	978		
92			97	2259	254		
93			146	1658	176		
94			416	10751	601		
95			88	1395	124		
96				334	54		
97				201			
98				209			
99				129			
100				119			
101				227			
102					69		
103				4172	180		
104				6517	123		
105				2126	289		
106			68		198		
107			121	4907	686		
108				2659	362		
109			197		89		
110				483			
111				159			
112							
113				84			
114				89			
115				74			
116				1055	132		
117				407	53		
118				1102	127		
119				1070	81		
120				2988	231		
121				902	131		
122			70	3167	314		
123			55	1136	164		
124				204			
125				67			
126				53			
127				55			

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) SA9320

m/e			573 (300)	673 (400)	823 (550)		
128				114			
129				272	55		
130				267	62		
131				194	47		
132				635	97		
133				321	75		
134				882	83		
135				2462	203		
136				772	67		
137				697	78		
138				109			
139							
140				43			
141							
142				80			
143				88			
144				118			
145				124			
146				395	41		
147				171			
148				157	[illegible]		
149				190			
150				139			
151				118			
152				49			
153							
154							
155							
156				48			
157				40			
158				97			
159				92			
160				118			
161				80			
162				56			
163				63			
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165				48			
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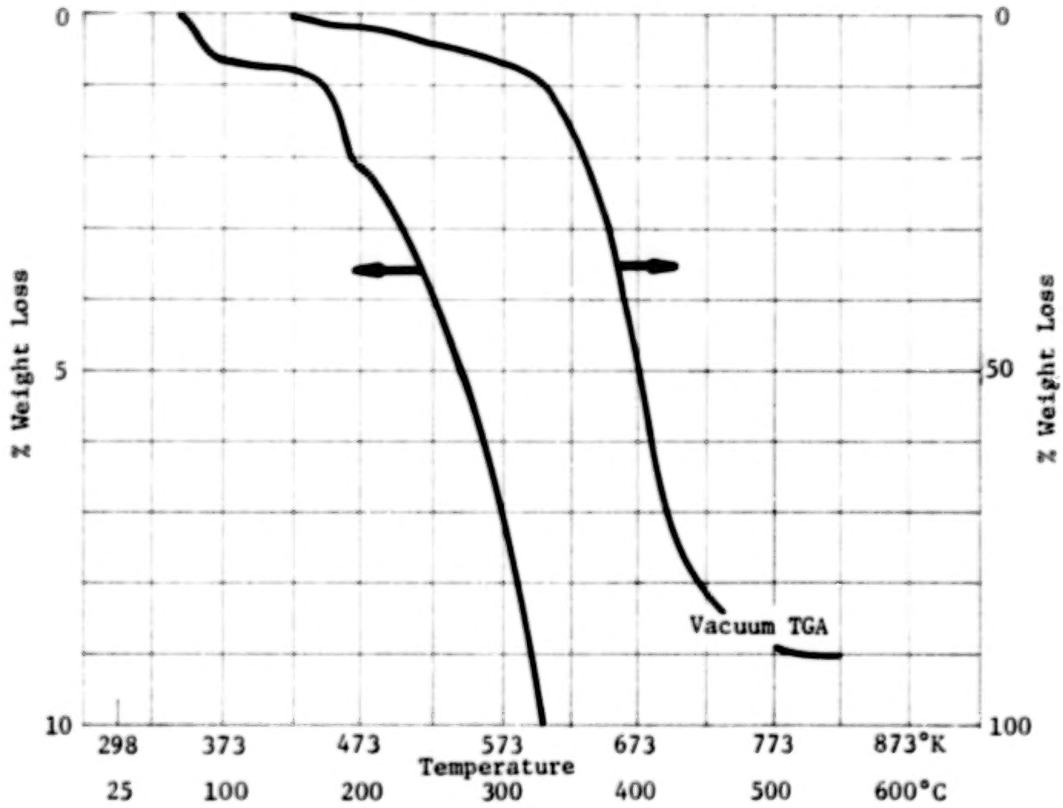
Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **1 hr. at 394°K (121°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **423°K (150°C)-773°K (500°C)**

a_o = **86.8%** of initial weight

$$k = 2.34\times10^{6}\ \exp\left(\frac{-22100}{1.98\ T°K}\right)\ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**3.4×10^8**	
373°K (100°C)	**3.1×10^6**	
423°K (150°C)	**8.5×10^4**	

Number and Relative Peak Intensity

Temperature, °K (°C) GA9414

m/e	298(25)	423 (150)	523 (250)	673(350)	723(450)	823 (550)	
14	3079	3246	3230	6033	6083	6754	
15	1720	2393	2700	10906	10792	7468	
16	12017	13063	15534	29967	16780	36377	
17	39008	37494	38368	55329	36377	32395	
18	100788	100609	100780	100801	100800	95373	
19	476	513	560	597	586	426	
20	1026	1055	1070	1376	1517	1621	
21							
22				382			
23							
24				696	653	237	
25		46	58	2497	3147	1048	
26	430	646	868	12519	15483	4986	
27	1047	1699	1820	14768	19950	6324	
28	34648	36240	35983	71303	57954	45013	
29	633	906	1048	8676	11550	3114	
30	1703	1849	1888	8006	4324	2577	
31	110	258	293	3296	1794	755	
32	9565	9469	8693	6787	8622	8535	
33				105	65		
34							
35			81	135			
36			169	553	462	104	
37		78	196	2654	2884	520	
38		160	338	4722	5562	906	
39		545	591	14309	22978	3280	
40	8008	8277	8071	15277	15259	9935	
41	128	439	493	5608	13020	1987	
42	103	213	653	8861	5513	1411	
43	208	475	778	6185	9588	2132	
44	2089	3678	6718	57506	7008	3278	
45		60	150	2596	933	303	
46				453	301		
47				775	510		
48				229	161		
49			51	1188	1168	158	
50		340	319	5505	6230	986	
51		178	182	4468	8726	1272	
52		193	223	3152	3577	535	
53		49		2781	5673	637	
54		145		2534	1991	242	
55		52	62	2988	6376	704	
56			45	1992	2129	490	
57				1411	1250	248	
58			70	1246	851	140	
59				473	305		
60				249	373		
61			53	828	1007	142	
62			88	1382	2098	269	
63		82	256	2553	5013	700	
64	83		195	1158	1646	261	
65		228	610	6637	9262	1137	
66	107	156	193	8400	7440	956	
67		54	55	1690	4638	294	
68				992	1404	119	
69				343	1139	73	
70				265	704		
71				230	230		
72				106	159		
73			56	347	308	44	
74				695	1261	147	
75				505	946	100	
76				360	818	82	
77		74		1559	9014	1034	
78		140		1501	3090	962	
79		68		2034	6223	527	
80		48		1335	1800	136	
81				670	2810	116	
82				265	954	50	
83				139	462	47	
84	203	190	172	357	501	242	
85				81	133		
86	40			82	240	58	
87					198		
88					50		
89				223	1219	129	
90				184	747	65	
91			46	1161	8912	1336	
92		48	180	870	2063	352	
93				1529	2695	177	
94				11642	9026	917	
95				1114	1857	74	
96				84	452		
97					174		
98					93		
99				55			
100				74			
101					111		
102				89	359		
103				348	1624	182	
104				607	832	71	
105				242	2081	346	
106				219	651	120	
107				520	4941	627	
108				744	1540	211	
109				175	443		
110					134		
111							
112							
113							
114							
115				47	1159	92	
116					363		
117					814	55	
118				117	373		
119				321	1980	217	
120				98	653	55	
121				110	4428	387	
122				66	1002	45	
123					110		
124							
125							
126							
127		156	389	673	215		

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
128					432		
129	259	315	314	497	726	288	
130					169		
131	156	150	125	321	754	259	
132	214	235	174	317	484	262	
133				41	481		
134	53			320	1122	160	
135					516		
136					818	67	
137					46		
138							
139							
140							
141					76		
142							
143					87		
144					45		
145					169		
146					48		
147					69		
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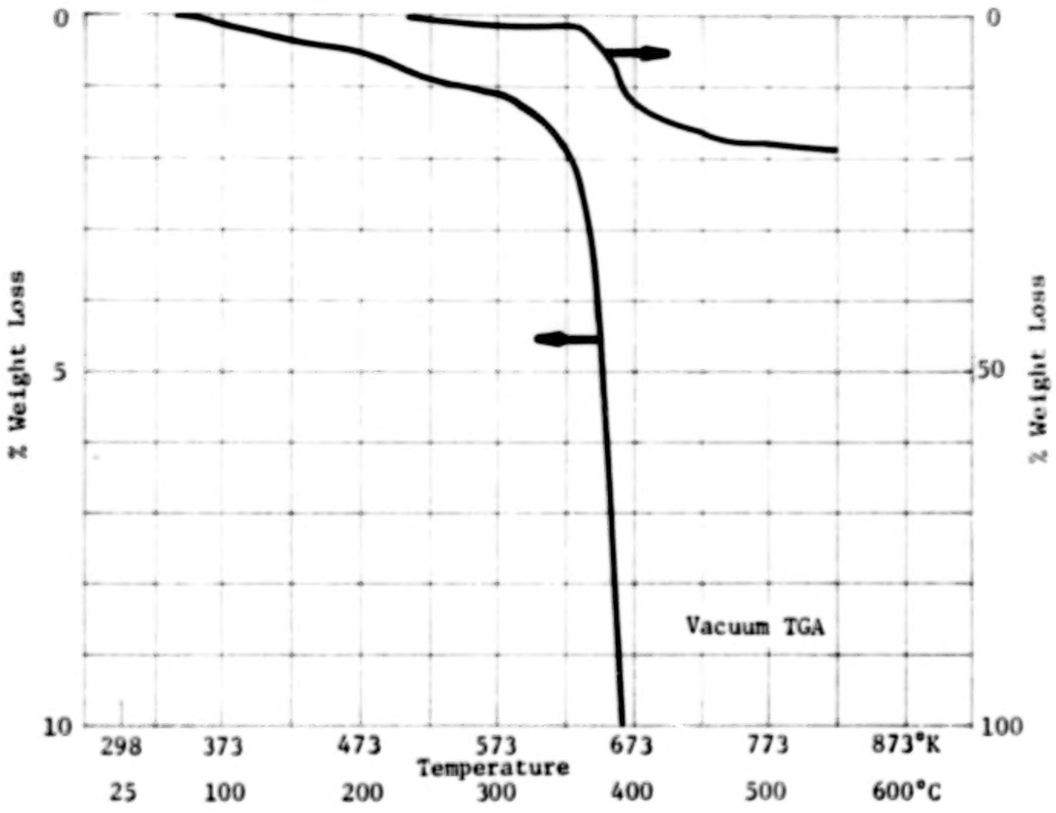
Chemical Characterization Summary

Mix Ratio: 1 pbw Resin to 20 pbw Catalyst
Cure: 4 hrs. at 339°K (66°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 603°K (330°C) - 698°K (425°C)

a_o = 17.2% of initial weight

$$k = 1.7 \times 10^{39} \exp\left(\frac{-114{,}800}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	3.0×10^{38}	
373°K (100°C)	1.1×10^{28}	
423°K (150°C)	1.9×10^{20}	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	623(350)	673 (400)	773 (500)		
14	1632	1664	3452	1913	172		
15	225	802	6059	1652	1353		
16	2613	3482	6499	3265	3462		
17	11249	9167	19881	8806	7325		
18	41634	33150	73504	31072	25150		
19	132		45				
20		115	218	114	88		
21							
22							
23							
24			161				
25	193				56		
26	200	733	5925	2609	900		
27							
28	25395	26200	37129	27039	24377		
29	196	430	8957	1531	586		
30	57	151		227	111		
31	59						
32	6334	5559	5704	5114	4892		
33							
34							
35							
36			73				
37							
38		49			54		
39			9110				
40	2130	2106	6308	5175	2046		
41			2032	845	176		
42	43	1742			156		
43				1365	126		
44	411	3021	10744	1466	615		
45			858	84			
46			70	45			
47			614	97			
48			40				
49				77			
50			2462	100	83		
51			2091	1883	125		
52			865				
53			1013	786			
54				71			
55		41	1998	750			
56			367	42			
57			493	40			
58			163				
59							
60			388	54			
61			636	262			
62							
63			1912	1145			
64					50		
65				2951	111		
66			7925	2913	85		
67			414	149			
68			151				
69							
70		44					
71		44					
72							
73			83	78			
74			408	171			
75			106	165			
76			45				
77			999	1868	88		
78			242				
79			415	670			
80			41	64			
81			43				
82							
83							
84							
85							
86							
87							
88							
89			138	162			
90			117				
91			894	1493	71		
92			95	87			
93			100	102			
94			13936	4081	103		
95			605	85			
96							
97							
98		573					
99		746					
100							
101							
102			52				
103			81	194			
104			43				
105			121	132			
106					43		
107			504	1492	58		
108			174	576			
109							
110							
111							
112							
113							
114							
115			49	42			
116			45				
117							
118			155				
119			928	899			
120			70	66			
121			133	1631			
122			54	201			
123							
124							
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126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	673 (350)	673 (400)	773 (500)		
128							
129		50	89	57	61		
130							
131			114	126	48		
132		44	97	130	57		
133			104				
134			1260	959			
135			111				
136			109	209			
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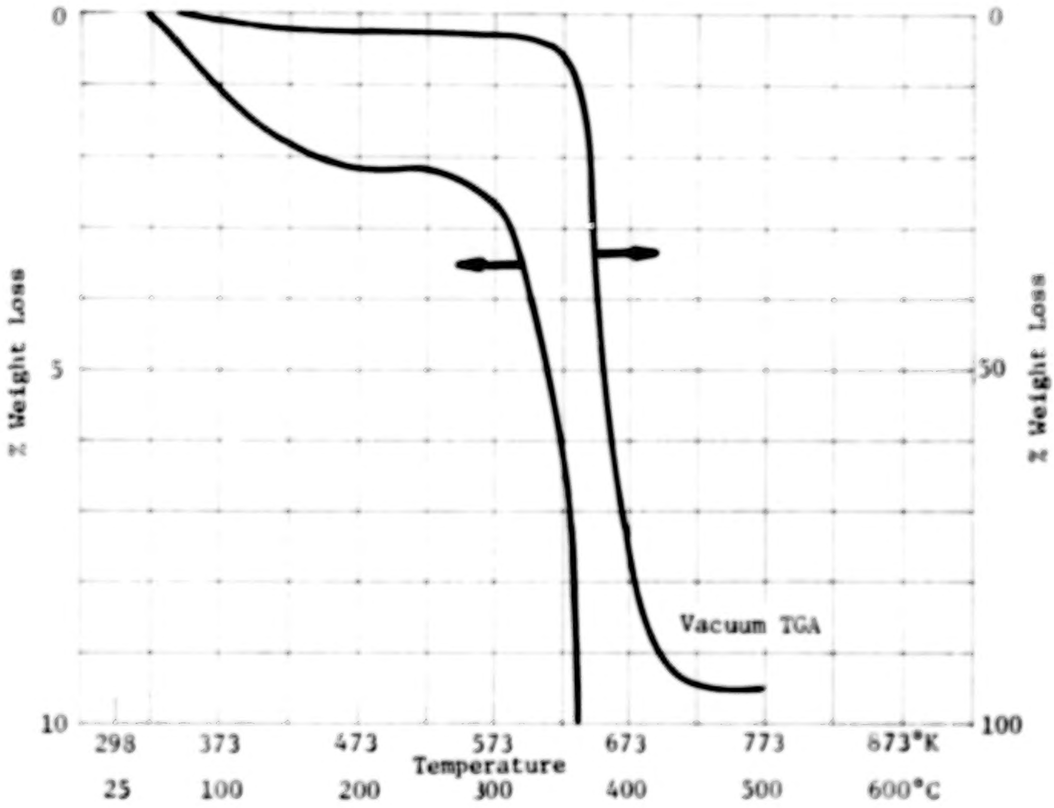
Chemical Characterization Summary

Mix Ratio: **2 pbw resin to 1 pbw activator**
Cure: **24 hrs. at ambient temperature**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **$523^\circ K$ ($250^\circ C$) - $773^\circ K$ ($500^\circ C$)**

a_o = **92.4% of initial weight**

$$k = 9.57\times10^{15} \exp\left(\frac{-55,500}{1.98\ T^\circ K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
$323^\circ K$ ($50^\circ C$)	**3.1×10^{19}**	
$373^\circ K$ ($100^\circ C$)	**2.8×10^{14}**	
$423^\circ K$ ($150^\circ C$)	**3.8×10^{10}**	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible] XP-3

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723(450)	823 (550)	
14	160	60	53	1573	262	178	
15	583	365	295	6556	1690	1543	
16	11636	7328	7039	8271	6272	5994	
17	22379	13605	12809	16923	10087	6817	
18	37131	21190	18526	25190	14645	12721	
19	3600	2563	4067	3639	1056	1497	
20	117	60		91	61		
21							
22							
23							
24							
25				980			
26		78		3320	853	390	
27		407		6336	2362	1561	
28	3059	2942	2566	15991	5113	3087	
29				11613	2306	620	
30				1324	157	67	
31				2265	480	42	
32	264	120	119	295	131	67	
33							
34							
35							
36				85	61		
37				495	109	62	
38		192			566	59	
39		1631		6806	3260	600	
40	692	1502	649	2871	1879	939	
41		61		6209	2271	718	
42						361	
43		62		10571	2461	632	
44	76	53		5794	118	305	
45		121		3301	384	53	
46							
47							
48				62			
49							
50		386		2221	612	56	
51		684		459	715	70	
52		69		626	311		
53				221	351		
54				69			
55				691	326		
56				1048	129		
57					199		
58				2582	290		
59				1012	213		
60				66			
61		66					
62					129		
63		621		67	389		
64							
65		1060		278	1176	62	
66				233	805		
67				50			
68				61			
69				90			
70				210			
71				67			
72				83			
73				76			
74							
75							
76						68	
77				73	673	102	
78				61	216		
79				94	331		
80				55	65		
81							
82							
83							
84							
85							
86				56			
87				105			
88							
89		67					
90							
91		8651			706	97	
92		5619					
93		70					
94				1631	2031	111	
95				97	69		
96							
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99							
100							
101							
102							
103							
104							
105					67		
106						84	
107				87	1559	175	
108				115	626		
109							
110							
111							
112							
113							
114							
115							
116							
117							
118							
119					396		
120							
121					767	61	
122					91		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
128							
129							
130							
131							
132							
133					62		
134				66	673		
135				63	673	64	
136					60		
137							
138							
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143							
144							
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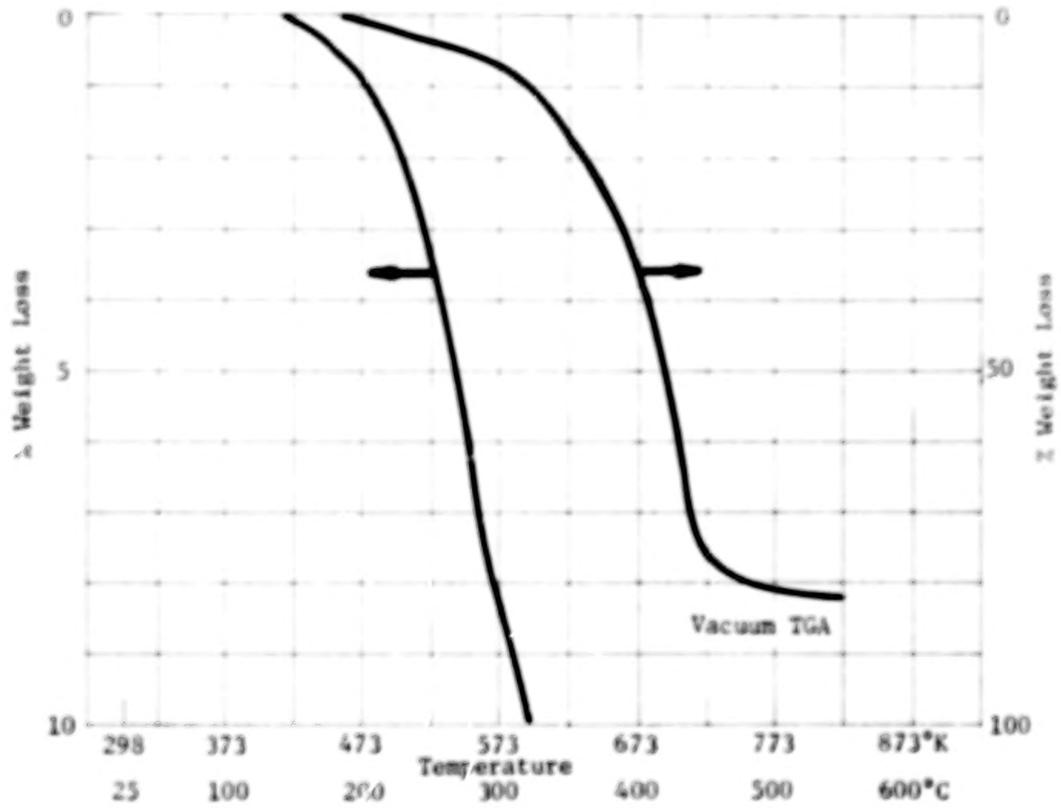
Chemical Characterization Summary

Mix Ratio: **100 pbw resin to 1.5 pbw catalyst**
Cure: **4 hrs. at 350°K (77°C), 1 hr. at 450°K (177°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **423°K (150°C)-773°K (500°C)**

a_o = **24.3%** of initial weight

$$k = 5.47\times10^{3} \exp\left(\frac{-12700}{1.98\ T^{\circ}K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**4.7×10^4**	
373°K (100°C)	**3.2×10^3**	
423°K (150°C)	**4.2×10^2**	

Number and Relative Peak Intensity

Temperature, °K (°C) Unknown: [illegible]

m/e	298(25)	423 (150)	523 (250)	623(350)	723 (450)	823 (550)	
14	29263	19820	2065	2576	2753	2083	
15	6995	5680	2206	3716	6003	6363	
16	55213	58965	5369	17587	8076	11638	
17	100323	100262	15767	29527	11505	18715	
18	100282	100327	60295	62130	46172	36652	
19	963	626					
20	3663	6283	230	326	246	222	
21							
22	51	66		375			
23	63						
24	42	215					
25	291	760	656	652	678	181	
26	2226	6099	5660	6831	3620	1607	
27	6523	8915	8522	6627	8657	3162	
28	100067	100601	33626	65064	61232	13656	
29	3656	6539	961	5261	4693	2132	
30	17009	18306	1975	2659	2693	2217	
31	398	640	191	2361	667		
32	65064	63626	5501	6767	5099	6711	
33	60	41					
34	213	206					
35	106						
36	69	286	78	56			
37	153	469	1697	887	1161		
38	269	1121	3356	1690	2631		
39	296	3711	13113	5732	11260		
40	30313	31187	5620	5621	6350		
41	667	1643	1095	3622	6561		
42	505	1220	566	1220	1955		
43	1337	1957	389	2502	6029		
44	12160	16523	6307	66968	12907		
45	172	857	62	960	663		
46	52	176		130	86		
47					256		
48		62					
49		263	805	223	239		
50	65	1726	6074	2615	2651		
51	58	1929	7310	2916	6579		
52	67	1361	5265	1527	1569		
53	60	681	3105	1288	2905		
54	41	626	2311	1599	636		
55	67	193	131	1366	2297		
56		86		1419	950		
57		69		571	305		
58		65	568	574	226		
59		316	157				
60		63			315		
61		367	386	257	397		
62		330	782	670	1522		
63		776	1075		2612		
64		195	222		702		
65		1322	3662	1291	4522		
66		590	1354	1733	4791		
67		162		1501	1206		
68		65		355	269		
69		45			96		
70							
71							
72							
73		48	121		65		
74		163	674	125	532		
75		81	148		134		
76		72			256		
77		1909	17816	2346	5662		
78	56	618	2728	563	1696		
79		3513	29715	5706	3202		
80		2630	18967	3623	1073		
81		194	1085	653	440		
82				214	66		
83							
84		61					
85							
86							
87							
88							
89		117			614		
90					501		
91		2764	1029	188	1520		
92		1727	280		420		
93		88			654		
94		55		1050	4711		
95					375		
96							
97							
98							
99							
100							
101							
102					87		
103					838		
104					78		
105		62			738		
106		50			93		
107					4356		
108					1736		
109							
110							
111							
112							
113							
114							
115					574		
116					81		
117					251		
118					44		
119					758		
120					168		
121					3317		
122					759		
123							
124							
125							
126							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Compound [illegible]

m/e					723 (450)		
128							
129							
130							
131					276		
132					65		
133					220		
134					333		
135					705		
136					667		
137							
138							
139							
140							
141							
142							
143							
144							
145					97		
146							
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240							

Table of Contents

Page

1. Tests . . . . vi 1/A9

2. Material Test Index . . . . viii 1/A11

3. Application Index . . . . xii 1/B5

4. Introduction 1 1/B8

5. Discussion of Test Methods

I. Thermochemical Tests 2 1/B9
II. Physical Property Tests 8 1/C1
III. Qualification Criteria for Viking Materials. . . . 10 1/C3

6. Data Section

Material	Manufacturer	Page	
Ablefilm 501-1	Ablestik Labs	15	1/C8
Ablefilm 535-1	Ablestik Labs	18	1/C11
ADX-41	Hysol	20	1/C13
Armstrong A2/ACT E	Armstrong	23	1/D2
Bacon FA13/BA-39	Bacon Industries.	26	1/D6
BC-328A/BC-328C	Dolph	29	1/D9
BLH-EPY 500	Baldwin-Lima-Hamilton . . .	32	1/D12
Bondmaster E645	National Starch and Chemical Corporation.	35	1/E1
C7-4248	Hysol	38	1/E4
CMC-15 Bonding Film	Circuit Material Co. . . .	41	1/E7
Coating G2735 on Electromagnetic Core	Magnetics Corp.	44	1/E10
Coating S8993-8Q2 on Electromagnetic Core	Magnetics Corp.	46	1/E12
Conductive Epoxy 5504A	E. I. DuPont.	48	1/E14
Conductive Epoxy 8294	E. I. DuPont.	51	1/F3
E-300 Insulating Film	Dyna-Therm Corp..	54	1/F6
EA901/B3	E. V. Roberts	57	1/F9
EA956	Hysol	60	1/F12
EA9320	Hysol	62	1/F14
EA9414	Hysol	65	1/G3
Eccobond 56C/Cat 11	Emerson and Cuming, Inc.. .	68	1/G6
Eccocoat EP-3	Emerson and Cuming, Inc.. .	71	1/G9
Eccoseal 1207/20	Emerson and Cuming, Inc.. .	74	1/G12
Eccostock R-25	Emerson and Cuming, Inc.. .	77	2/A4
ECF-55C	Epoxy Coating Co.	80	2/A7

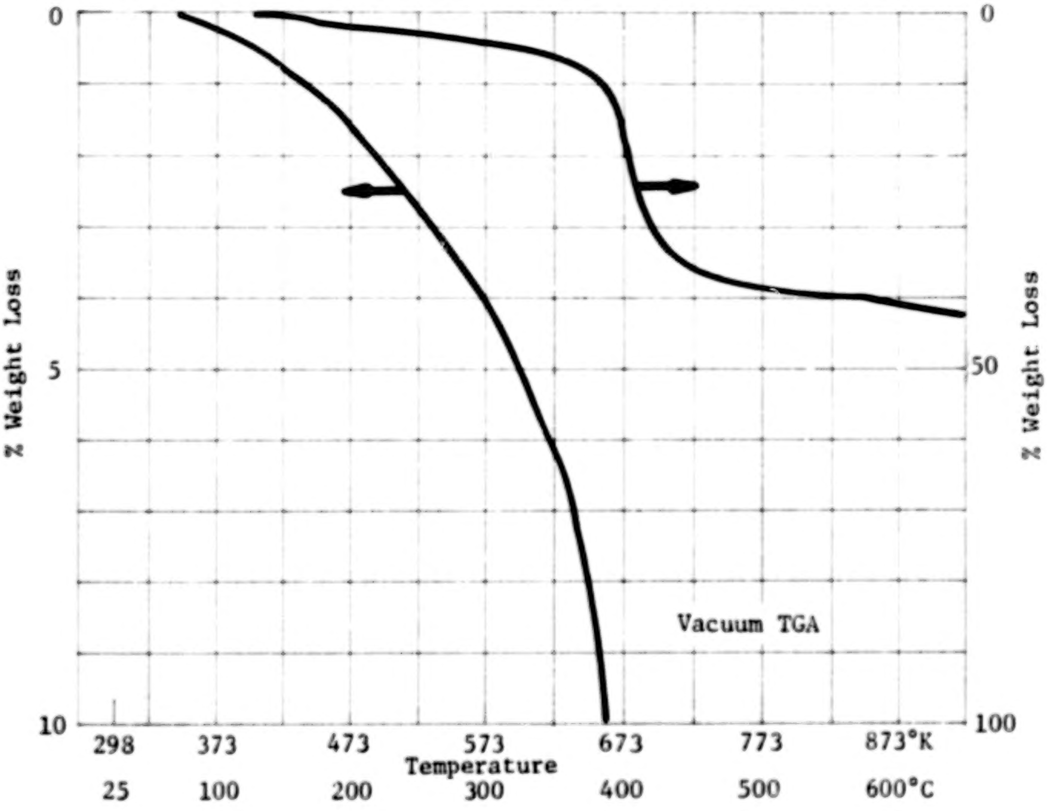
		Page	
EG818T	Mica Corp.	83	2/A10
Epocast 203	Furane Plastics, Inc. . . .	86	2/A13
Epon 815/A	Ceilcote/Eastman.	89	2/B2
Epon 828/Cat 2/Flex 871	Shell Chemical Co.	91	2/B4
Epon 828/MPDA/120 Fiberglass Cloth	Shell Chemical Co.	94	2/B7
Epon 828/Versamid 125	Shell Chemical Co.	97	2/B10
Epon 929/B	Hysol	100	2/B12
Epo-Tek H43	Epoxy Technology, Inc. . .	102	2/C1
Epo-Tek H72	Epoxy Technology, Inc. . .	105	2/C4
Epo-Tek 417	Epoxy Technology, Inc. . .	108	2/C7
Epo-Tek 417	Epoxy Technology, Inc. . .	111	2/C10
Epoxy 450 Tubing	3M Co.	114	2/C13
ES-222	Polyscientific.	117	2/D2
FM-40	American Cyanamic Co. . . .	120	2/D5
FM-96 Supported Film	American Cyanamid Co. . . .	123	2/D8
High Temp 221	High Temp Resins.	127	2/D12
HT435 Film Adhesive	American Cyanamid Co. . . .	130	2/E1
Hysol AS-7-4315	Hysol	133	2/E4
Hysol C9-4183/H2-3561	Hysol	136	2/E7
Hysol R9/H2	Hysol	139	2/E10
Impregnant 3-BA-4	Bacon Industries.	142	2/E13
Ink, Cat-L-Ink 50-100, -Cat. 20	Wornow Process Paint. . . .	145	2/F2
Ink, Cat-L-Ink 50-300-9	Wornow Process Paint. . . .	148	2/F5
Ink, Cat-L-Ink 50-407-9	Wornow Process Paint. . . .	151	2/F8
Ink, M-9-N/Cat A	Wornow Process Paint. . . .	154	2/F11
Ink, Markem 7224	Markem Corp.	157	2/F14
Ink, M-O-N, Black	Wornow Process Paint. . . .	160	2/G3
Ink, Red, 50-507-9	Wornow Process Paint. . . .	163	2/G6
Ink, Yellow, 50-202-9	Wornow Process Paint. . . .	166	2/G9
Laminate, Epoxy/Glass 102-21	Mica Corp.	169	2/G12
Laminate, Mil-P-13949 FL-GFN	Fortin.	172	3/A4
Laminate, E-787	U.S. Polymeric, Inc. . . .	174	3/A6
Laminate, G-10 FR Clad	Norplex	176	3/A8
Laminate, G-10 FR Unclad	Norplex	179	3/A11
Laminate, L-P-509 GR G-11	Formica Corp.	182	3/A14
LCA-4V/BA-5	Bacon Industries.	184	3/B2
Lefkoweld 46LM 52	Leffingwell	187	3/B5
MF500F-124 Microwave Absorber	Emerson and Cuming, Inc. .	190	3/B8
Paint, Cat-A-Lac 473-3-1/x304	Finch Paint	193	3/B11
Paint, Brolite Gloss Black Enamel	Andrew Brown.	195	3/B13

		Page	
Paint, Brolite Gloss White Enamel	Andrew Brown	198	3/C2
Paint, Nextel 401-C10	3M Co.	201	3/C5
Scotchcast 241	3M Co.	204	3/C8
Scotchcast 583 Tape	3M Co.	207	3/C11
Skyspar A423/66	Andrew Brown	209	3/C13
SMRD 100F-90	General Electric	212	3/D2
Stycast 36D	Emerson and Cuming, Inc.	215	3/D5
Stycast 1263/Cat. 11	Emerson and Cuming, Inc.	218	3/D8
Stycast 2651/Cat. 9	Emerson and Cuming, Inc.	221	3/D11
Stycast 2651/Cat. 11	Emerson and Cuming, Inc.	224	3/D14
Torr Seal A/B	Varian Associates	227	3/E3
Trucast 111M/901	Fenwal, Inc.	230	3/E6
Trucast 111M/902	Fenwal, Inc.	233	3/E9

Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **598°K (325°C)-823°K (550°C)**

a_o = **32.1%** of initial weight

$$k = 1.14\times10^{25} \exp\left(\frac{-78000}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**5.3×10^{27}**	
373°K (100°C)	**4.1×10^{20}**	
423°K (150°C)	**1.6×10^{15}**	

Number and Relative Peak Intensity

Temperature, °K (°C) Feedstock E-25

m/e	298 (25)	473 (200)	573 (300)	673 (400)	823(550)		
14	760	3122	3296	6530	6306		
15	879	1280	1744	10103	13952		
16	5254	10263	10546	23081	27076		
17	8330	27122	26157	39566	22986		
18	18341	82641	78675	100437	63632		
19	68	134	171	386	121		
20	324	615	653	891	696		
21							
22				504	234		
23							
24				1058	292		
25		49	236	3888	1323		
26	221	544	1506	10838	6478		
27	673	1201	2361	24603	7672		
28	8112	31326	34451	85119	51792		
29	135	534	1415	15104	3100		
30	1472	2202	2355	3953	2854		
31			128	1943	343		
32	2266	8815	8642	8380	7322		
33				71			
34							
35							
36				671	136		
37			57	4259	1136		
38			110	7196	2086		
39	55	177	442	26355	7286		
40	4047	5805	6002	14630	8113		
41		98	215	10906	2858		
42		72	215	3749	1299		
43	42	150	405	9906	2155		
44	1183	2528	5754	66078	35810		
45			48	1487	625		
46			56	469	191		
47				966	51		
48				225	40		
49				1503	513		
50				6814	3307		
51				6214	4159		
52				3222	1779		
53				5322	1118		
54				13707	445		
55			226	6755	743		
56			265	3424	506		
57			91	1541	154		
58				1768	161		
59				112			
60				320	86		
61				1153	411		
62				1895	771		
63				3657	1719		
64	43		43	1169	406		
65	52	42	42	9034	2471		
66	41		50	10993	1894		
67				16657	1838		
68				1710	324		
69				282	93		
70				100	63		
71				52			
72				118			
73				492	251		
74				1372	560		
75				654	335		
76				1325	371		
77				3555	3773		
78				1806	3626		
79				4047	2201		
80				1250	806		
81				2081	267		
82				12339	302		
83				940	44		
84	78	61	71	262	147		
85							
86				77	65		
87				55	42		
88							
89				402	331		
90				360	179		
91		54		1451	4349		
92				352	1669		
93				783	182		
94				15601	913		
95				1106	47		
96				184	48		
97							
98							
99							
100							
101							
102				75	51		
103				333	222		
104				608	144		
105				317	1576		
106				66	602		
107				1297	674		
108				1092	316		
109				96			
110				85			
111							
112							
113							
114							
115				174	211		
116					82		
117				87	99		
118				143	40		
119				249	147		
120				91	293		
121				787	225		
122				164	66		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	573 (300)	673 (400)	823 (550)		
128				47	43		
129	105	98	90	169	149		
130							
131	59	61	65	413	142		
132	91	87	88	290	140		
133				57			
134				185	52		
135							
136				113			
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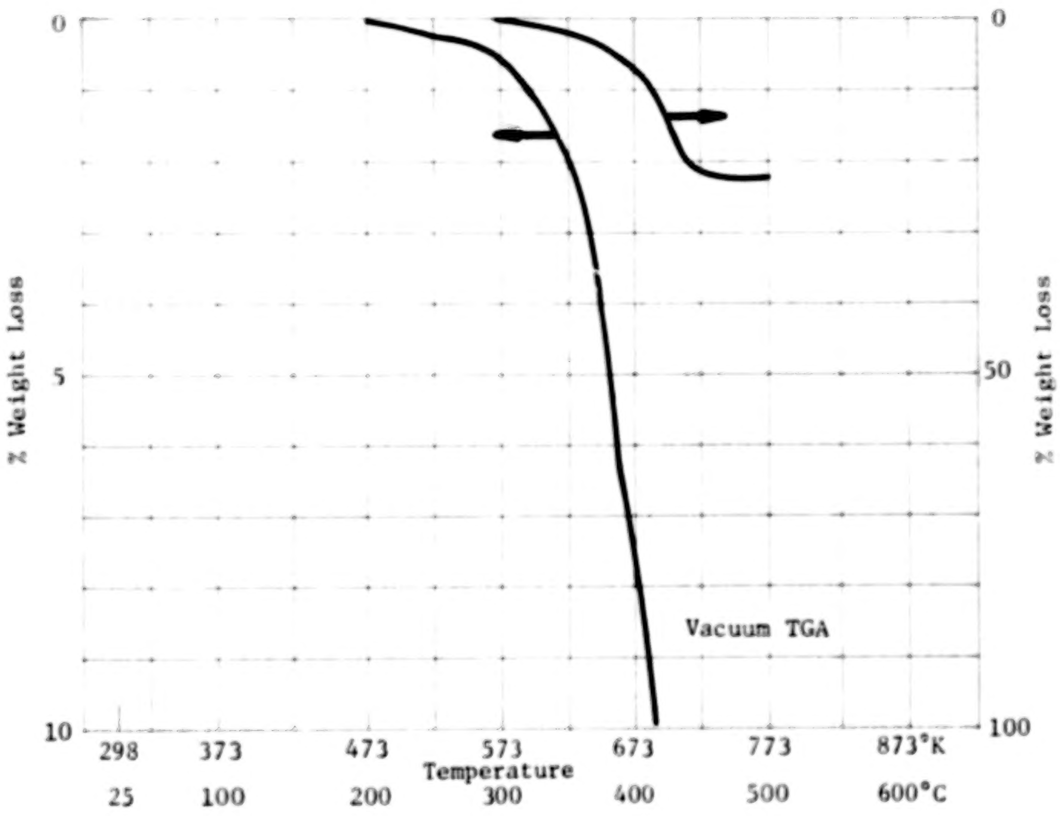
Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **2 hrs. at 394°K (121°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C) - 773°K (500°C)**

a_o **=22.1%** of initial weight

$$k = 2.78 \times 10^6 \exp\left(\frac{-22,600}{1.98\ T^\circ K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**4.7×10^8**	
373°K (100°C)	**4.1×10^6**	
423°K (150°C)	**1.1×10^5**	

Number and Relative Peak Intensity

Temperature, °K (°C)

ECP-550

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	613	496	497	1017	585		
15	606	481	536	1700	824		
16	6572	4665	4556	5292	4090		
17	17938	12226	10977	11221	9002		
18	47280	30734	27069	28674	22797		
19	547	528	504	459	223		
20	100	79	67	91	62		
21							
22							
23							
24				117			
25				549	84		
26	99	121	221	2882	781		
27	398	346	543	2727	919		
28	8368	6961	7075	14706	8683		
29	350	349	426	3000	699		
30	159	132	129	696	197		
31	380	262	237	590	294		
32	1939	1530	1379	1324	1115		
33							
34							
35							
36				80			
37				439	82		
38				852	247		
39	65	78	121	2627	930		
40	1073	1005	1036	2289	1365		
41	118	119	166	1408	515		
42			66	1072	249		
43	138	142	198	2336			
44	875	856	1916	7665	5921		
45	62			166	92		
46							
47				80			
48							
49				176			
50			45	877	296		
51				702	325		
52				354	96		
53				507	146		
54				263			
55				800	233		
56			60	460	117		
57				533	78		
58				275			
59							
60							
61				76			
62				203	53		
63				447	189		
64					59		
65				1254	459		
66				1692	490		
67				325	59		
68				116			
69				73			
70							
71							
72							
73							
74				96			
75							
76							
77				322	294		
78				251	139		
79				379	148		
80				256			
81				181			
82							
83							
84							
85							
86							
87							
88							
89							
90							
91				226	338		
92					42		
93							
94				4487	1211		
95				376	47		
96							
97							
98							
99							
100							
101							
102							
103							
104							
105				41	83		
106							
107				307	322		
108				237	137		
109							
110							
111							
112							
113							
114							
115							
116							
117							
118				62			
119				43	42		
120							
121					300		
122							
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
128							
129				56	47		
130							
131				203	178		
132				174	119		
133							
134				41	55		
135							
136					68		
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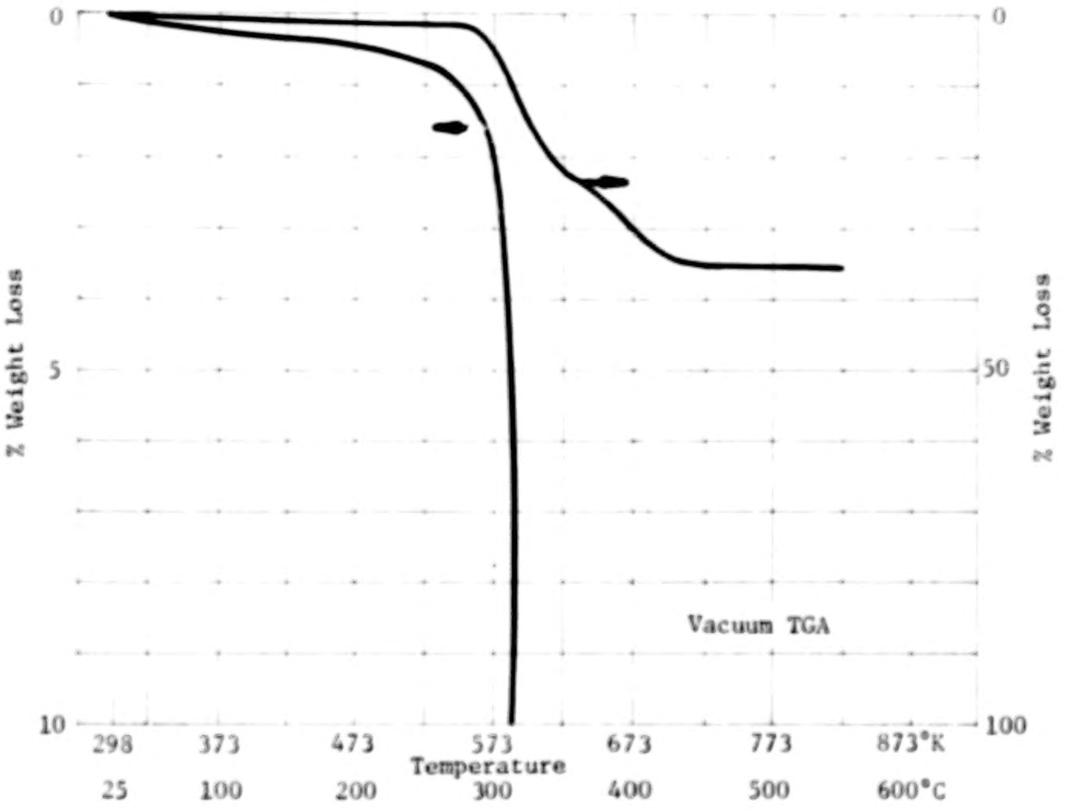
Chemical Characterization Summary

Mix Ratio: **As received sheet stock**
Cure: **As received**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **533°K (260°C)-583°K (310°C)**

a_o = **21%** of initial weight

$$k = 6.85\times10^{10} \exp\left(\frac{-32300}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	8.5×10^{10}	
373°K (100°C)	8.9×10^{7}	
423°K (150°C)	4.8×10^{5}	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	423 (150)	548 (275)	623 (350)	698 (425)	773 (500)	
14	397	599	576	382	602	501	
15	79	228	915	1193	680	706	
16	1713	1693	3002	2751	1684	2077	
17	7607	6592	8741	8317	5694	5393	
18	29062	23955	29337	26626	20386	19645	
19	306	413	400	382	157	184	
20	115	90	172	264	137	106	
21							
22							
23							
24				73			
25			64	452	241	63	
26	73	209	851	3347	1912	1142	
27	175	481	1617	2942	2142	1177	
28	10192	19455	20974	23621	21012	20260	
29	107	421	704	2029	1355	576	
30	67	227	238	312	306	216	
31		93	46	279	139	71	
32	4941	4769	4506	4096	3960	3702	
33		43					
34							
35							
36				257	100		
37				1086	499	81	
38			48	2320	1040	261	
39		63	324	7253	4044	1332	
40	1472	1466	1764	4619	2798	1063	
41		56	152	1036	679	288	
42		270	432	1063	507	139	
43		143	371	2501	1794	289	
44	325	1331	8000	5769	1010	1180	
45		224	64	93	51		
46				63			
47				317	59		
48							
49				278	85		
50			150	1784	1081	371	
51			86	1851	1419	417	
52			111	363	294	108	
53				1000	607	152	
54				109	69		
55				1556	601	142	
56			56	222	58		
57				75			
58				71	70		
59							
60							
61				303	106		
62				726	291		
63				1516	382	171	
64				328	130		
65				4947	2252	522	
66			68	6189	2426	534	
67				259	62		
68				147			
69							
70							
71							
72							
73		262					
74				240	92		
75				120			
76				44	46		
77				831	1253	362	
78			40	173	215	60	
79			51	337	366	124	
80					45		
81				64			
82							
83							
84							
85							
86							
87							
88							
89				53	45		
90							
91						41	
92				617	685	199	
93				71			
94			200	260	81		
95				9337	1391	774	
96			138	386	51		
97				78			
98							
99							
100							
101							
102							
103							
104				46	56		
105							
106					43		
107							
108				51	203	69	
109							
110							
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112							
113							
114							
115							
116							
117							
118							
119							
120				115	68		
121							
122				153	213		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	423 (150)	548 (275)	623 (350)	698 (425)	773 (500)	
128							
129							
130							
131							
132							
133							
134							
135				42			
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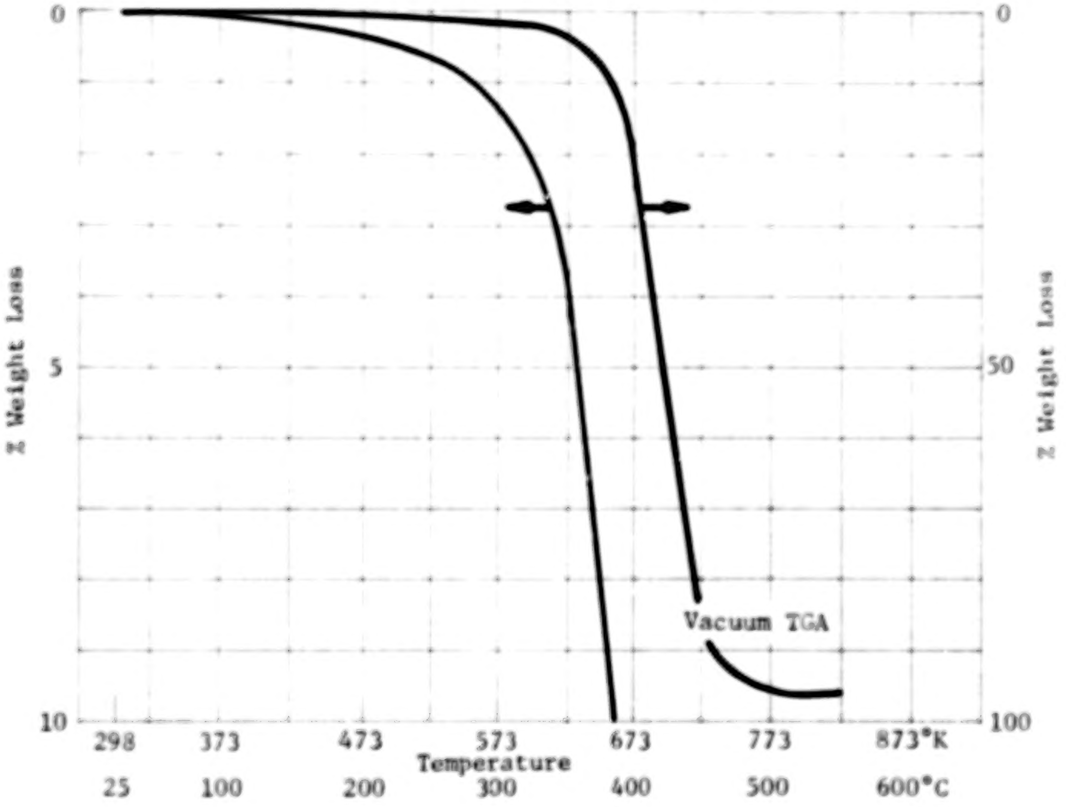
240							

Epocast 203

Chemical Characterization Summary

Mix Ratio: **100 pbw of A to 100 pbw of B to 1 pbw of D-2**
Cure: **4 hrs. at 338°K (65°C), 4 hrs. at 423°K (150°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **408°K (135°C)-623°K (350°C)**

a_o = **96%** of initial weight

$$k = 5.1\mathrm{x}10^4 \ \exp\left(\frac{-19300}{1.98\ T°K}\right)\ \mathrm{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.5×10^{10}	
373°K (100°C)	2.7×10^{8}	
423°K (150°C)	1.2×10^{7}	

Isothermal weight loss in nitrogen - 0.14%

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	598 (325)	698 (425)	798 (525)		
14	2963	2868	3290	12000	4065		
15	1049	1166	2703	37566	4774		
16	9896	9907	10359	26268	13066		
17	33162	26551	26557	38639	26732		
18	103536	64358	77616	112671	76214		
19	180	149	137	1676	110		
20	619	693	556	1982	567		
21							
22				621			
23							
24			66	2671	57		
25			430	9093	614		
26	691	646	6396	58009	3716		
27	1125	1311	7260	138961	6079		
28	29569	29146	38171	169615	38016		
29	629	512	2831	52373	2632		
30	2099	2190	2588	6364	2096		
31		60	477	9689	301		
32	8675	6250	8134	10316	7966		
33							
34							
35							
36				1005			
37			412	11370	310		
38			673	26430	805		
39	67	163	6026	156761	6856		
40	3167	1730	6518	41352	7111		
41	91	172	4060	102909	2513		
42	51	90	960	14907	720		
43	112	765	852	26817	1400		
44	3617	1636	5963	67186	3692		
45			135	7216	163		
46				1167			
47				1570			
48				762			
49			132	4068	51		
50			1267	25917	1006		
51			1313	36696	1402		
52			960	17953	562		
53			1625	40113	1012		
54			7109	173262	2659		
55		62	1221	28670	711		
56			597	9651	215		
57			176	4713	44		
58			43	3249			
59				798			
60				1030			
61				3057			
62				5168	109		
63			159	11310	556		
64				3639	60		
65			523	21990	770		
66			564	22320	690		
67			8325	196395	3194		
68			527	14106	126		
69				1676			
70				645			
71				516			
72				804			
73				1932			
74				4911	65		
75				[illegible]			
76				[illegible]			
77			507	18129	972		
78			207	6659	139		
79			1034	22185	753		
80			317	6927	113		
81			763	18171	291		
82			6866	145221	2279		
83			363	10701	65		
84				1088			
85				531			
86				123			
87				702			
88				399			
89				2168			
90				1864			
91				6303	829		
92				1467	56		
93				1806			
94			192	10870	664		
95				1051			
96				567			
97				626			
98				793			
99				453			
100							
101				402			
102				771			
103				1722			
104				837			
105				1551	205		
106				561			
107				6759	390		
108			82	9013	142		
109				1562			
110				1173			
111							
112				632			
113				324			
114							
115							
116				1317			
117				555			
118				759			
119				912			
120				1800			
121				780			
122				3090	50		
123				1221			
124				360			
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, ^{0}K (^{0}C) Epocast 203

m/e	298 (25)	473 (200)	598 (325)	698 (425)	798 (525)		
128				369			
129				521			
130				528			
131				315			
132				1218			
133				771			
134				786			
135				1260			
136				660			
137				783			
138							
139				303			
140							
141							
142							
143							
144							
145							
146				423			
147				321			
148				309			
149				315			
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151				318			
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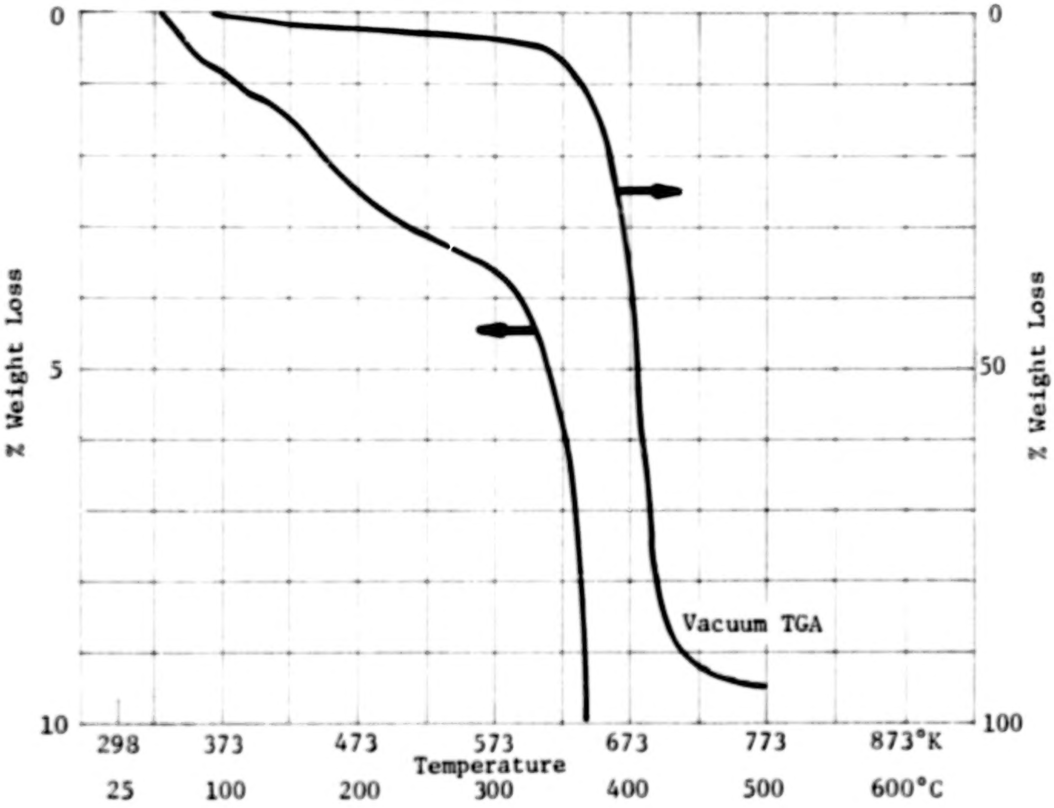
Chemical Characterization Summary

Mix Ratio: **100 pbw resin to 8 pbw activator**
Cure: **1½ hrs. at 393°K (120°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **498°K (225°C) - 748°K (475°C)**

a_o = **95.1%** of initial weight

$$k = 8.0\times10^5 \ \exp\left(\frac{-22{,}500}{1.98\ T°K}\right) \ \mathrm{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	1.4×10^9	
373°K (100°C)	1.2×10^7	
423°K (150°C)	3.4×10^5	

Number and Relative Peak Intensity

Temperature, K (°C) Epon 815/A

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	822	1169	824	2847	1062		
15	242	688	417	5793	932		
16	2076	1678	1824	4026	2442		
17	7973	7218	5476	7921	4546		
18	33745	25127	23176	35000	18291		
19	145	188	104	769	71		
20	244	295	196	297	245		
21							
22							
23							
24		47	70	769	71		
25	82	277	306	2653	359		
26	383	1232	1268	12945	1860		
27	612	2710	2210	21660	2913		
28	24513	26441	25243	50533	26214		
29	388	4117	2401	26512	2023		
30	537	917	905	5113	939		
31	111	1697	695	9923	447		
32	4713	4585	4147	4857	3619		
33			60	405			
34				41			
35		54	48				
36		69	55	825	48		
37		94	175	5503	307		
38	49	204	256	10577	551		
39	101	908	855	33448	2184		
40	2622	2831	2799	13843	3059		
41	129	2166	1387	17739	1284		
42	52	468	787	10225	593		
43	275	1074	1059	26233	1434		
44	469	1095	1011	8445	932		
45	42	339	195	3475	205		
46				357			
47		40		1387			
48			40	219			
49		121	106	1330	71		
50		123	128	6151	486		
51	45	80	152	5974	627		
52		75	66	2385	217		
53		67	92	4028	298		
54		72	71	1130	64		
55		621	214	5394	359		
56		509	522	4162	216		
57		1456	453	5660	303		
58		557	299	2686	143		
59		81	57	709			
60				502	41		
61				1548	49		
62				2091	107		
63				3664	348		
64		132	176	1087	83		
65			48	7579	477		
66		46	67	9506	296		
67				1176	44		
68				550			
69				264			
70				202			
71		50		195			
72		50	66	521			
73		97		320			
74				741			
75				340			
76				245			
77				1906			
78				604	60		
79				936	77		
80				466			
81				190			
82				87			
83				43			
84				70			
85				50			
86				117			
87				149			
88							
89				163			
90				192			
91				549	110		
92				126			
93				236			
94				3761	68		
95				295			
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103				61			
104							
105				56			
106							
107				244			
108				149			
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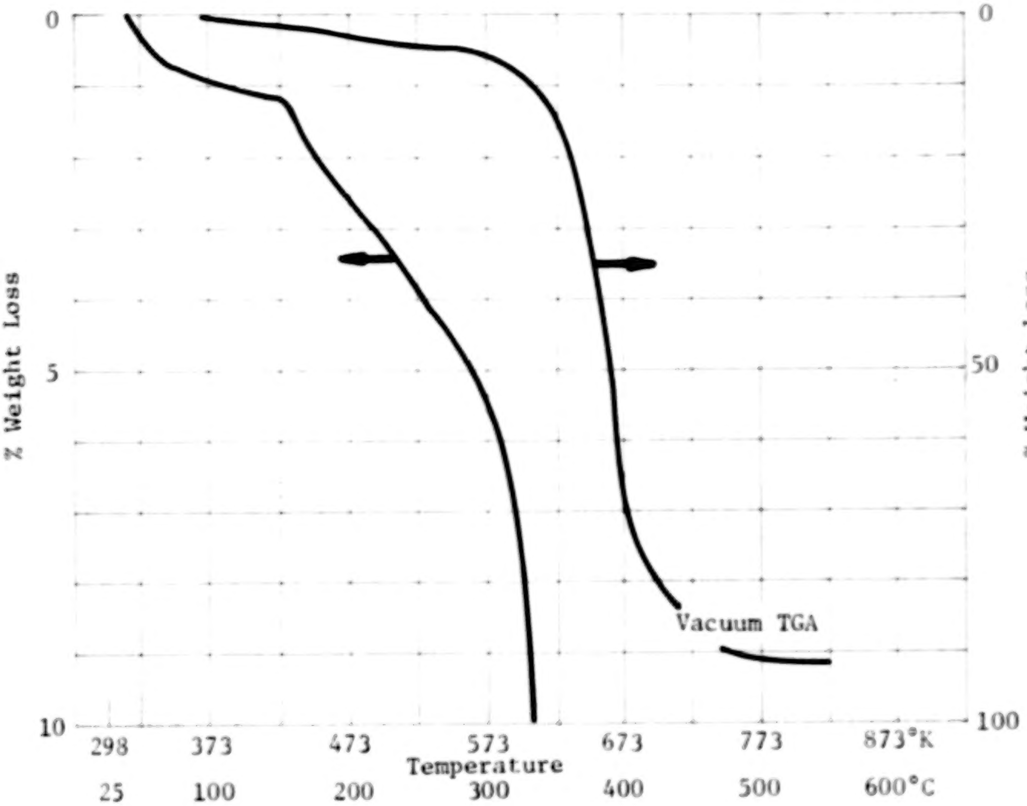
Chemical Characterization Summary

Mix Ratio:35 pbw resin to 65 pbw catalyst to 15.5 pbw Flexibilizer
Cure: 2 hrs. at 403°K (130°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 523°K (250°C)-773°K (500°C)

a_o = 90.6% of initial weight

$$k = 3.9 \times 10^{17} \exp\left(\frac{-53,300}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	2.4×10^{18}	
373°K (100°C)	3.4×10^{13}	
423°K (150°C)	6.7×10^{9}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Epon 828/Cat Z/Flex 871

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
14	2216	2200	2331	10364	3903		
15	453	545	1234	22977	6274		
16	3224	3012	3280	18827	7961		
17	11277	9896	11216	55366	11422		
18	37217	32440	36757	101113	35497		
19	364	332	327	661	273		
20	154	[illegible]	164	628	237		
21							
22				72			
23							
24		42	76	1301	273		
25	47	144	325	4712	1279		
26	194	914	1599	19476	6437		
27				19622	10636		
28	23685	24228	23547	56009	34565		
29	283	481	975	33437	7551		
30	414	444	475	3788	1714		
31		64		5198			
32	5159	4995	4723	6534	4669		
33				47			
34				51			
35				43			
36			48	912	108		
37		40	87	7231	962		
38		59	110	13219	1041		
39	54	242	721	39735	9007		
40	971	1005	1149	16805	3339		
41	60	286	954	7899	8561		
42	49	88	172	7545	3562		
43	71	315	290	14335	5960		
44	453	517	966	16882	2353		
45		52	73	3006	264		
46				614	55		
47				2510	86		
48			41	403			
49			86	2134	302		
50		124	599	9899	1818		
51		65	195	10856	2409		
52		45	155	3356	954		
53		45	123	5188	1702		
54			61		616		
55		122	646	8307	3222		
56		40	116	1826	1880		
57		51	59	1280	1663		
58		40		863	171		
59				298	64		
60				1411	123		
61				2350	198		
62				3928	469		
63			73	7733	1154		
64		42	54	2511	357		
65		54	134	18735	1911		
66	46	47	110	23723	1525		
67		57	134	2176	1025		
68				1028	313		
69			42	340	646		
70				278	650		
71				146	382		
72				155	57		
73				608	57		
74				2051	232		
75				1121	139		
76				837	139		
77		42	111	7008	2123		
78			110	2034	639		
79			64	3111	1134		
80				684	253		
81			88	422	383		
82			66	191	159		
83		41	164	204	187		
84	51	43	56	139	203		
85				86	162		
86				120	48		
87				136			
88				55			
89				1161	219		
90				793	139		
91		70	539	4315	1579		
92			94	765	228		
93				1358	293		
94				26990	1245		
95				1818	153		
96				102	43		
97				48	48		
98				43	49		
99							
100							
101				74			
102				127			
103				741	197		
104		45	150	421	88		
105			44	705	315		
106				380	166		
107				2307	1062		
108				929	388		
109				67			
110							
111							
112							
113							
114							
115			61	444	179		
116				69			
117			121	281	87		
118				446			
119				1805	246		
120				430	59		
121				1662	495		
122				233	114		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Epon 871/Cat Z/Flex 671

m/e			523 (250)	623 (350)	723 (450)		
128							
129			45	75	47		
130							
131				126	41		
132				69			
133				83			
134				643			
135				920	68		
136				90			
137				157			
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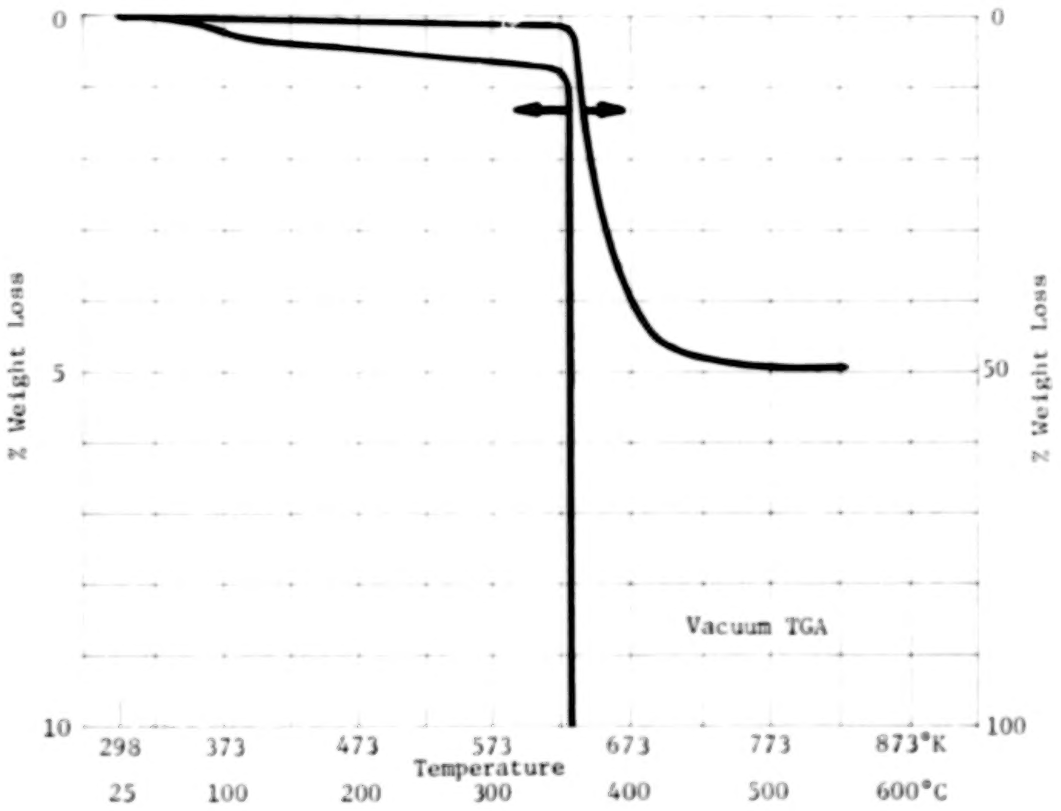
Chemical Characterization Summary

Mix Ratio: 100 pbw of Resin to 14 pbw of Hardener
Cure: 1 hr. at 339°K(66°C), 2 hrs. at 394°K (121°C),
2 hrs. at 450°K (177°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 473°K (200°C)-773°K (500°C)

a_o = 50% of initial weight

$$k = 1.8\times10^{8} \exp\left(\frac{-\ 30200}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.1×10^{12}	
373°K (100°C)	2×10^{9}	
423°K (150°C)	1.5×10^{7}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Epon 828/MNA/120 Fiberglass Cloth

m/e	298(25)	623(350)	673 (400)	773(500)			
14	7838	12606	10050	9657			
15	326	13767	4010	2760			
16	4977	16601	7696	6981			
17	13706	37368	16816	9951			
18	51566	101160	53023	35913			
19	41	279	188	66			
20	679	862	606	681			
21							
22		92					
23							
24		761	395	92			
25	63	3006	1695	572			
26	385	11509	7677	2959			
27		10602	8851	3761			
28	110360	141330	122680	111790			
29	1126	27650	6605	2696			
30	509	3180	1669	1129			
31		3108	1241				
32	26660	26619	23917	22903			
33		196	106				
34	82	110	60	101			
35		176	55				
36		669	356	93			
37		4256	2669	328			
38		7620	5266	628			
39	163	20795	17628	2652			
40	6261	16610	12129	7186			
41	167	4996	3989	1306			
42	139	7052	2609	698			
43	273	19105	4420	1070			
44	1035	26396	3699	1626			
45	105	2796	885	225			
46		442	260				
47		1915	769				
48		276	123				
49		1795	1067	159			
50	42	8601	5968	926			
51	56	5316	7719	1231			
52		2599	2665	451			
53		3270	4296	652			
54		966	936	170			
55		6281	3932	537			
56		1678	112	131			
57		2034	519	92			
58		1906	438	101			
59		428	284				
60		1150	717	61			
61		1856	1352	165			
62		2988	2609	337			
63		5725	5988	819			
64		1751	1969	231			
65		15102	10767	1233			
66		18896	9628	969			
67		1580	1190	167			
68		1035	696				
69		466	110				
70		332	81				
71		84	56				
72		282	136				
73		592	508	74			
74		1982	1628	194			
75		805	1119	103			
76		570	855	100			
77		2503	8267	1293			
78		1137	2567	446			
79		1735	3672	523			
80		654	831	128			
81		610	406	63			
82		224	87				
83		104					
84		109	42				
85		67	88				
86		145	186				
87		75	260				
88							
89		1008	1633	204			
90		837	1153	170			
91		1603	6389	1199			
92		455	936	170			
93				103			
94		37766	13962	1731			
95		2457	976	68			
96		206	48				
97							
98							
99							
100							
101							
102		111	341	47			
103		351	1706	206			
104		138	390	77			
105		350	1178	372			
106		159	293	109			
107		1462	5793	1069			
108		1090	2806	464			
109		97					
110			201				
111							
112							
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115							
116		356	851	185			
117		61	186				
118		121	426	102			
119		1127	461	60			
120		1025	3427	327			
121		376	1008	115			
122		1433	5179	505			
123		266	1208	159			
124			65				
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Epon 828/MDA/120 Fiberglass Cloth

m/e	298 (25)	623 (350)	673 (400)	773 (500)			
128							
129			127	41			
130			99				
131			49				
132		270	596	113			
133		121	270	60			
134		337	994	65			
135		1121	2047	245			
136		225	920	128			
137		314	996	40			
138			76				
139							
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145			42				
146		95	229	60			
147			57				
148			113				
149		120	182				
150		52	169				
151		42	166				
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159		65	51				
160			102				
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164		75	100				
165		159	68				
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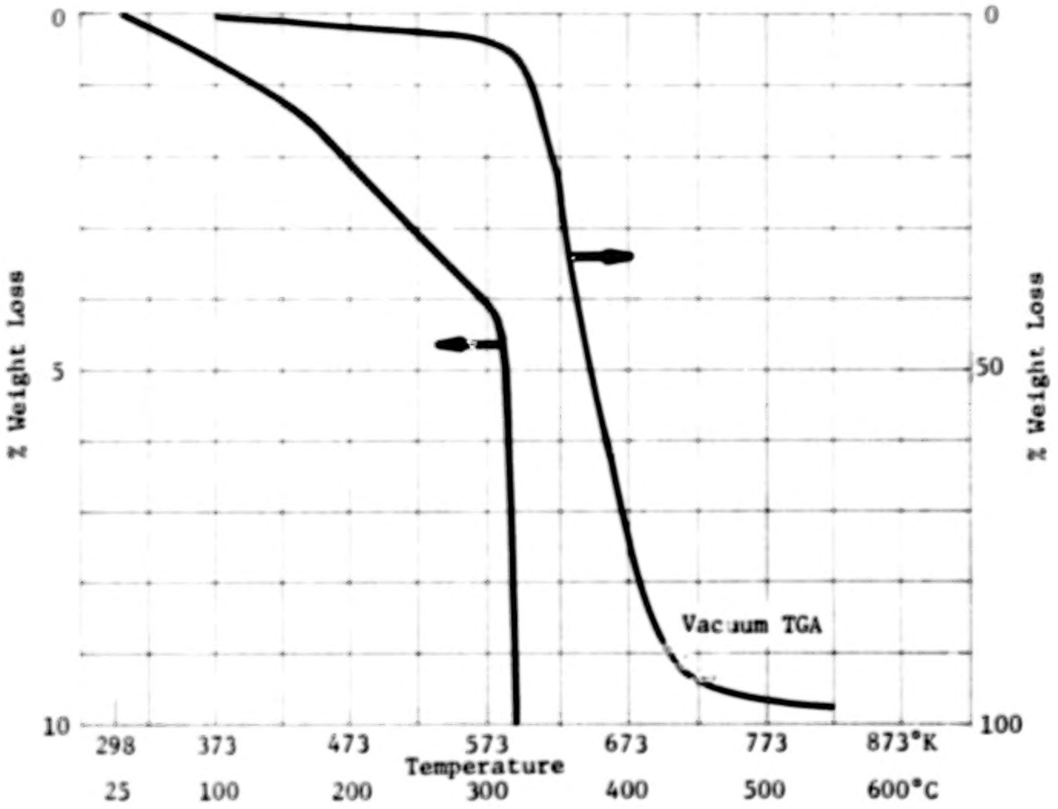
Epon 828/Versamid 125

Chemical Characterization Summary

Mix Ratio: 1 pbw resin to 1 pbw activator
Cure: 24 hrs. at room temperature

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 573°K (300°C)-723°K (450°C)

a_o = 93.3% of initial weight

$$k = 1.6 \times 10^{31} \exp\left(\frac{-89,900}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	4.5×10^{29}	
373°K (100°C)	2.9×10^{21}	
423°K (150°C)	1.6×10^{15}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Epon 826/Versamid 125

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
14	1489	1349	1528	5360	2151		
15	259	287	754	15062	3343		
16	2491	2222	2256	14637	4266		
17	11082	8524	8445	42880	16587		
18	40266	31166	31003	100564	27082		
19	46	67	64	156	76		
20	126	86	132	373	116		
21							
22							
23							
24				567	86		
25							
26	133	96	310	17930			
27							
28	22068	20314	20911	63083	27282		
29	186	259	1216	17211	5336		
30	80	44	92	13006	1096		
31	53	61	56	6164			
32	5078	4567	4368	4806	4050		
33				52			
34							
35				45			
36							
37							
38							
39			50	26092	7605		
40	2067	1900	2023	16538	6832		
41	42	44	73				
42	50	47	114	10565	5367		
43	76	156	142				
44	283	346	986	36182	1605		
45				3284	160		
46					40		
47				1606	50		
48					70		
49							
50				7626			
51				6757	2092		
52				5783			
53				5862	1472		
54							
55				5604	2967		
56				4632	1936		
57					1539		
58				4359	234		
59				965	52		
60				847	55		
61					175		
62							
63				3668	1030		
64							
65	44				2104		
66				14605	1617		
67				6783	875		
68				1461	280		
69				599	537		
70				874	565		
71				554	309		
72				411	48		
73				377	70		
74				899	116		
75				415	78		
76							
77				2262	2191		
78							
79				2526	1163		
80				2924	197		
81				1230	265		
82				375	133		
83				174	110		
84				298	127		
85				137	109		
86				69	118		
87				57	56		
88							
89				394	103		
90							
91				1713	1874		
92					138		
93					157		
94				23497	1337		
95				1941	168		
96				129	44		
97				81	44		
98				60			
99							
100				45			
101							
102							
103				243	268		
104				73	328		
105				257	52		
106				580	98		
107				2546	1610		
108				3479	433		
109				440			
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112				99			
113							
114				62			
115				110	177		
116							
117				92	60		
118				459	53		
119				1509	710		
120				650	153		
121				1935	1398		
122				1031	215		
123				96			
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

m/e	348 (75)	423 (150)	523 (250)	623 (350)	723 (450)		
128					44		
129		46	46	96	132		
130		76		44			
131		53		314			
132		52	47	47			
133				[illegible]			
134				346			
135				74			
136				288			
137				56			
138				86			
139				319			
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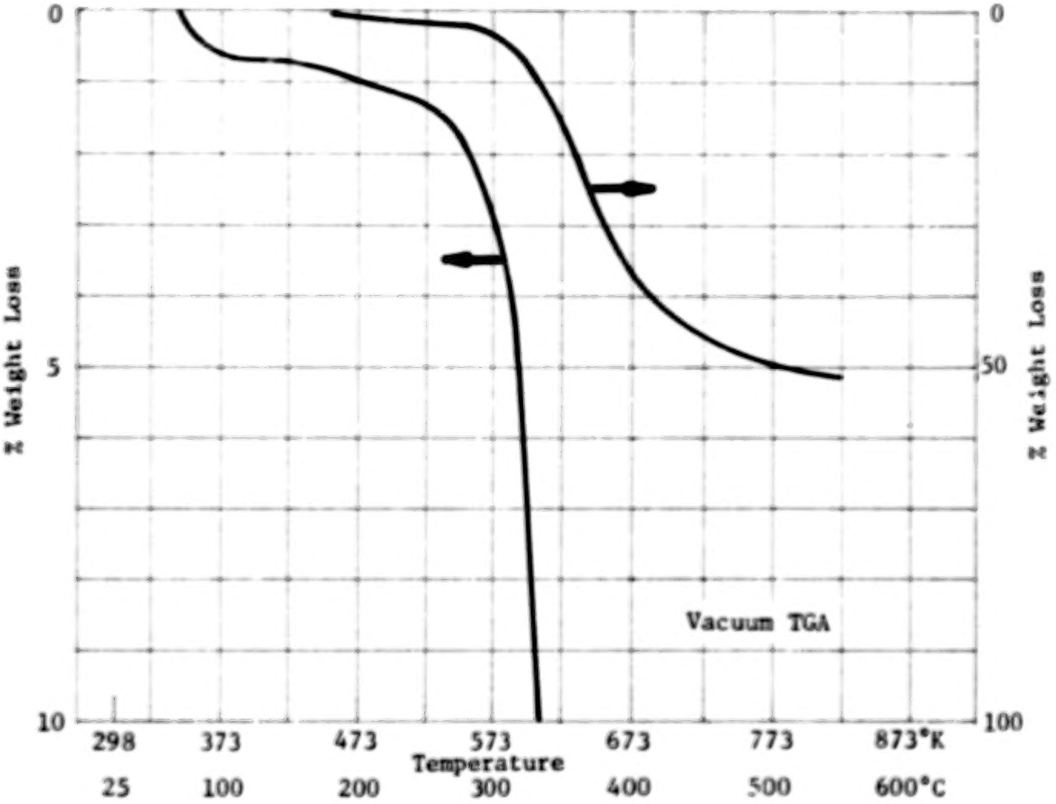
Chemical Characterization Summary

Mix Ratio: 100 pbw resin to 33 pbw activator
Cure: 1 hr. at 422°K (149°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 473°K (200°C) - 823°K (550°C)

a_o = 51.6% of initial weight

$$k = 1.93 \times 10^{10} \exp\left(\frac{-32,100}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	2.1×10^{11}	
373°K (100°C)	2.5×10^{8}	
423°K (150°C)	1.4×10^{6}	

Number and Relative Peak Intensity

Temperature, °K (°C)　　Spec 929

m/e							
14							
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22		DATA NOT AVAILABLE					
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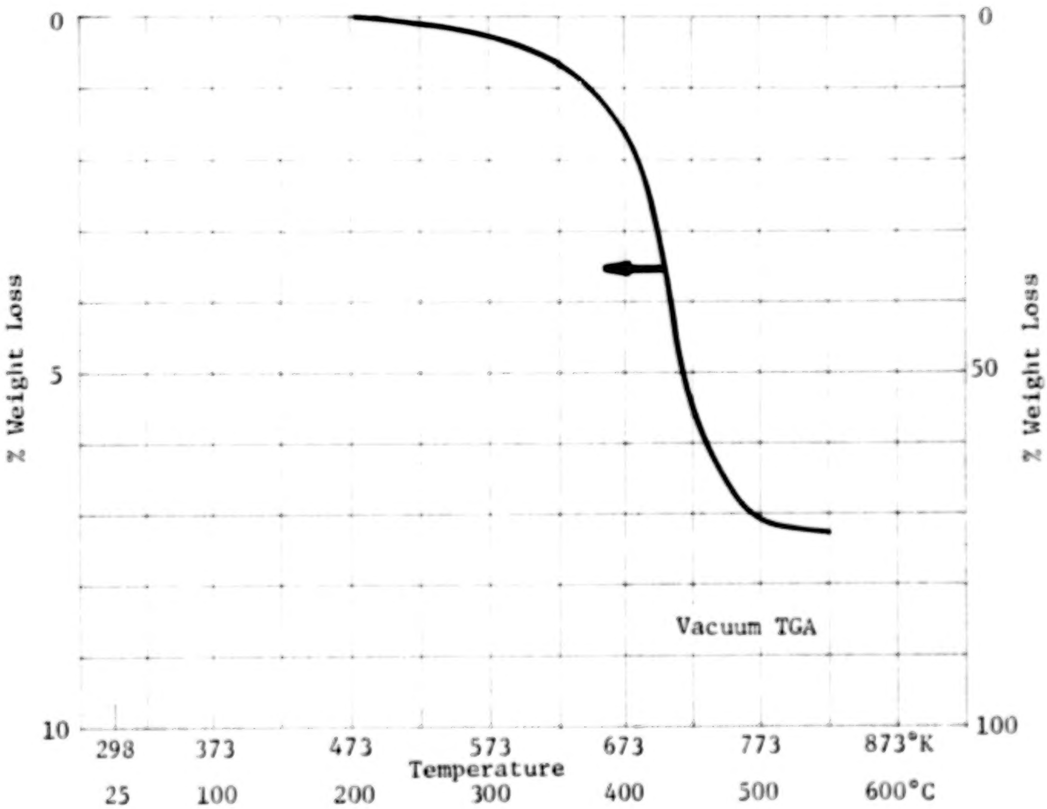
Epotek H43

Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **15 min. at 423°K (150°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **573°K (300°C) - 773°K (500°C)**

a_o = **6.6%** of initial weight

$$k = 5.08\text{x}10^{11} \exp\left(\frac{-39{,}900}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**1.4×10^{15}**	
373°K (100°C)	**3.4×10^{11}**	
423°K (150°C)	**5.7×10^{8}**	

Number and Relative Peak Intensity

Temperature, °K (°C) Epotek H43

m/e	298(25)	523(250)	623(350)	723 (450)	823(550)		
14	1505	1344	1666	3083	2842		
15	485	624	1760	5230	1940		
16	5450	4800	5347	6386	6276		
17	25079	20098	20430	23877	19534		
18	79110	67024	61835	72042	58548		
19	178	179	237	366	173		
20	309	397	459	689	510		
21							
22							
23							
24			40	241	50		
25		52	362	1232	170		
26	204	475	2016	5871	1331		
27	560	952	2977	7394	1857		
28	24612	22571	27735	40899	28316		
29	273	735	4083	11306	1622		
30	1115	996	2095	3603	1251		
31	135	177	813	3798	587		
32	6199	5437	5391	5743	5417		
33							
34							
35			73				
36			213	226	56		
37			150	956	83		
38			327	1609	199		
39	67	114	1274	5354	934		
40	5464	5655	5951	8248	6570		
41	48	100	1261	4166	564		
42		56	996	2900	284		
43	58	154	1947	11301	951		
44	785	1018	1832	3807	1902		
45			221	1584	140		
46				50			
47				54			
48							
49			83	141			
50			374	976	258		
51			92	993	282		
52			114	363	87		
53			85	753	132		
54			55	214			
55			243	1221	140		
56			326	862	102		
57			566	1097	49		
58			195	916			
59				138			
60				82			
61				101			
62				142	50		
63				484	99		
64		51	105	112			
65			51	557	131		
66			54	609	97		
67				137			
68			43	79			
69				146			
70			41	157			
71				58			
72				125			
73				53			
74				242			
75				48			
76							
77				580	132		
78				268	86		
79				269	67		
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81				61			
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90				42			
91				235	104		
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94				524	88		
95				41			
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105				63			
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107				269	65		
108				124	40		
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121				74			
122				49			
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Epotek 943

m/e				723 (450)			
128							
129							
130							
131				42			
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134				59			
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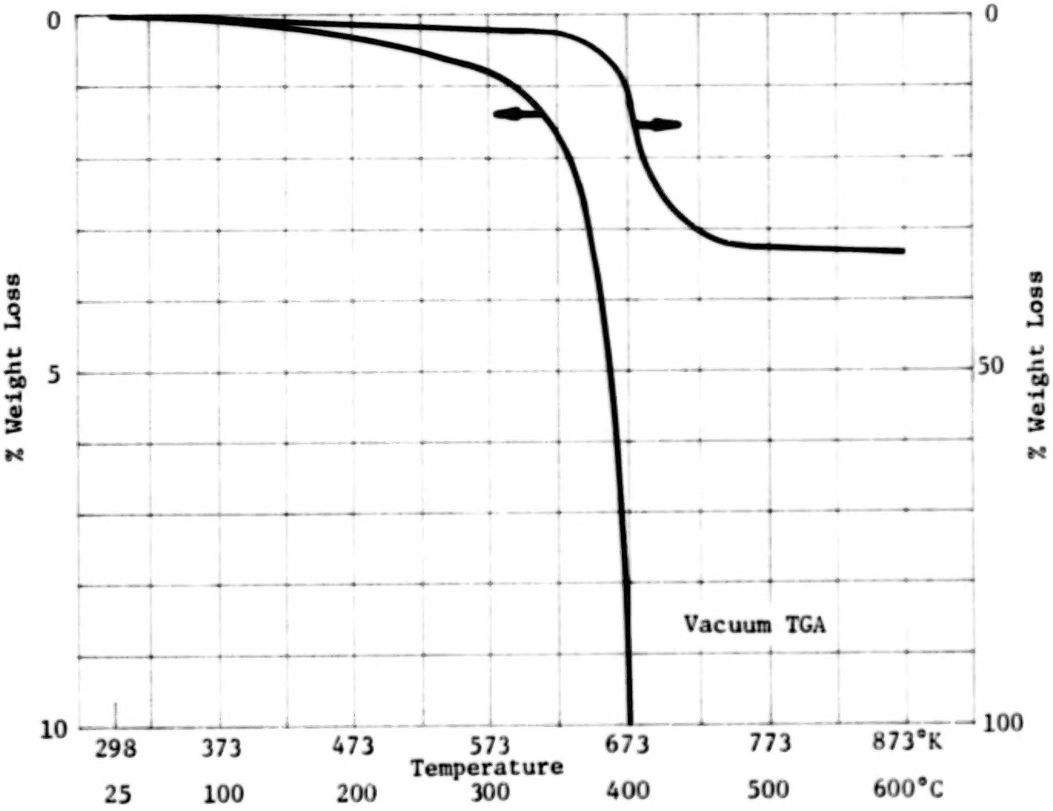
Epotek H72

Chemical Characterization Summary

Mix Ratio: **100 pbw resin to 4 pbw activator**

Cure: **20 min. at 373°K (100°C), 24 hrs. at 411°K (138°C) and 10^{-5} Torr**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **298°K (25°C) - 633°K (360°C)**

a_o = **32%** of initial weight

$$k = 1.35\times10^{4} \exp\left(\frac{-\ 17500}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**3.5×10^{7}**	
373°K (100°C)	**8.8×10^{5}**	
423°K (150°C)	**5.2×10^{4}**	

Number and Relative Peak Intensity

Temperature, °K (°C)　　　Epotek H77

m/e	298 (25)	473 (200)	623 (350)	698 (425)	748 (475)	823 (550)	
14	2215	2092	3017	8013	3507	3938	
15	734	748	2937	18038	5216	7569	
16	5229	4860	6872	13673	9264	12397	
17	20512	17473	23653	32296	17276	16569	
18	69435	58347	79672	101722	56435	53571	
19	592	606	702	1459	551	465	
20	396	380	566	898	556	494	
21							
22				66			
23		43					
24			186	965	236	138	
25	41	65	812	3571	1022	625	
26	377	529	3858	16012	4822	3140	
27	523	633	4511	19543	5588	3572	
28	25900	25471	35800	72616	38569	37009	
29	369	494	3374	23500	3410	2216	
30	379	371	873	4163	1249	1043	
31	135	143	882	9946	612	540	
32	6164	5817	5677	6258	5646	5542	
33				170			
34							
35							
36			108	691	152	118	
37			386	3253	870	560	
38			697	5422	1619	1055	
39	104	140	3121	17595	5445	3418	
40	3156	3158	4436	9962	5021	4749	
41	62	108	2563	10462	2196	1117	
42	54	78	1376	8039	1272	650	
43	81	146	3943	32803	2367	1545	
44	1562	2147	8616	14122	3220	2842	
45	57	63	967	5743	480	341	
46			68	404	96	61	
47				416	106	89	
48				176	41		
49			124	1109	359	208	
50			719	5289	2050	1304	
51			664	6012	2551	1632	
52			463	2593	1061	679	
53			669	4077	1659	990	
54			2353	1833	654	361	
55			577	3621	1113	662	
56			378	1591	279	157	
57			402	3866	193	114	
58			401	3530	159	99	
59			47	898	69		
60			208	980	153	69	
61				1096	287	198	
62			54	1529	376	382	
63			134	3093	1296	906	
64			67	1051	435	283	
65			322	4560	1793	1258	
66	40	43	348	4168	1602	1226	
67			2725	2090	627	327	
68			227	656	207	121	
69			46	846	304	138	
70				240	44		
71				313	43		
72				451	53		
73			47	554	102	49	
74			100	1764	435	252	
75				713	220	97	
76				801	274	139	
77			288	4488	2171	1198	
78			220	2111	901	601	
79			566	2912	1401	822	
80			236	992	447	229	
81			330	798	405	214	
82			2138	1029	464	257	
83			137	215	46	41	
84	62	94	124	284	137	121	
85				208			
86				295	53	42	
87				317	51		
88				66			
89				752	317	176	
90				733	348	221	
91		42	123	2599	1344	1321	
92			54	544	264	414	
93			73	376	115	59	
94			206	4957	1798	1472	
95				582	178	113	
96				175			
97				50			
98				65			
99				61			
100				51			
101				92			
102				155			
103				383	172	70	
104				190	83		
105				603	278	225	
106				170	117	202	
107				4296	2042	994	
108			43	2546	1326	783	
109				234	88		
110				297	460	280	
111							
112							
113							
114				46			
115				308	90		
116				60			
117				95			
118				87			
119				160	40		
120				134	46		
121				742	351	57	
122				532	358	81	
123				118	103		
124				89	88		
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Epitek 871

m/e	298 (25)	473 (200)	623 (350)	698 (425)	748 (475)	823 (550)	
128				53			
129	64	72	95	192	141	95	
130				40			
131		52	58	315	142	90	
132	68	60	77	197	116	79	
133				66			
134				275	51		
135				95			
136				119	42		
137							
138							
139							
140							
141							
142							
143							
144							
145				101	45		
146							
147				588	109		
148				458	75		
149							
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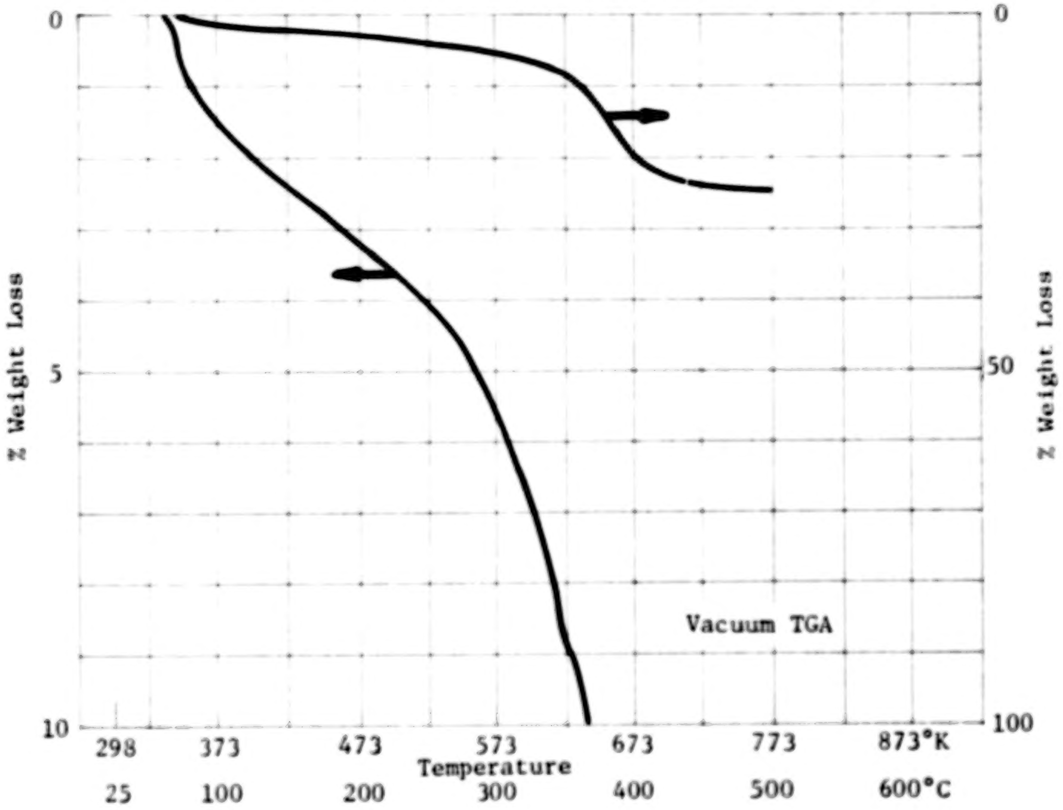
Chemical Characterization Summary

Mix Ratio: **15 pbw Resin to 1 pbw Activator**
Cure: **4 hrs. at 398°K (125°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C) - 698°K (425°C)**

a_o = **20.3%** of initial weight

$$k = 1.6 \times 10^{16} \exp\left(\frac{-50,700}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	9.5×10^{17}	
373°K (100°C)	2.3×10^{13}	
423°K (150°C)	6.9×10^{9}	

Number and Relative Peak Intensity

Temperature, °K (°C) Epoxy 417

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	5900	6338	6903	6701	6724		
15		651	1260	2056	1319		
16	7650	7596	8035	8799	7625		
17	20150	27496	28711	26124	23246		
18	130270	97016	86315	95465	84246		
19		261	246	243	170		
20		452	472	536	515		
21							
22							
23							
24				222	44		
25			106	1055	251		
26		466	760	5048	1433		
27			2816	5818	2792		
28	111370	100598	100404	100592	100638		
29		2253	3296	4869	2133		
30		1339	1216	1979	1523		
31		500	736	1002	498		
32	21630	21564	20367	20442	20285		
33							
34			42	43	43		
35							
36		71	90	245	78		
37		63	255	1436	159		
38		143	693	2902	415		
39		780	2503	8920	1562		
40	3760	5371	5953	8604	5951		
41		1029	1626	2088	1012		
42		794	718	1416	528		
43		805	2206	2639	927		
44	1110	2970	4221	4979	2633		
45		510	455	734	360		
46				133	42		
47				361			
48				68			
49			73	528	74		
50		108	754	3027	454		
51		182	1091	3494	611		
52		66	423	1261	195		
53		115	624	1922	308		
54		56	136	462	94		
55		286	528	1716	366		
56		232	222	366	161		
57		139	164	377	135		
58			42	157			
59				57			
60			42	210			
61			44	444			
62			112	884	88		
63		40	404	1992	169		
64			112	604	63		
65		66	554	4075	363		
66		72	564	4421	379		
67		42	95	440	95		
68			41	181	47		
69		46	44	73	53		
70				55			
71							
72							
73				132			
74			82	424	53		
75				259			
76				223			
77		172	1158	2698	414		
78		73	313	892	98		
79		85	928	1822	287		
80			327	433	68		
81			45	121			
82							
83							
84							
85							
86							
87							
88							
89			146	441	47		
90			303	563	55		
91		56	226	1641	217		
92				197			
93				347	57		
94		50	471	4634	318		
95				292			
96							
97							
98							
99							
100							
101							
102							
103				128			
104							
105			48	141	43		
106				77	41		
107		85	846	1368	244		
108		85	955	1344	176		
109			41	75			
110							
111							
112							
113							
114							
115				77			
116							
117				42			
118							
119				564			
120				105			
121				610			
122				93			
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
128							
129							
130							
131				70			
132				56			
133				104			
134				578			
135				63			
136				94			
137							
138							
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142							
143							
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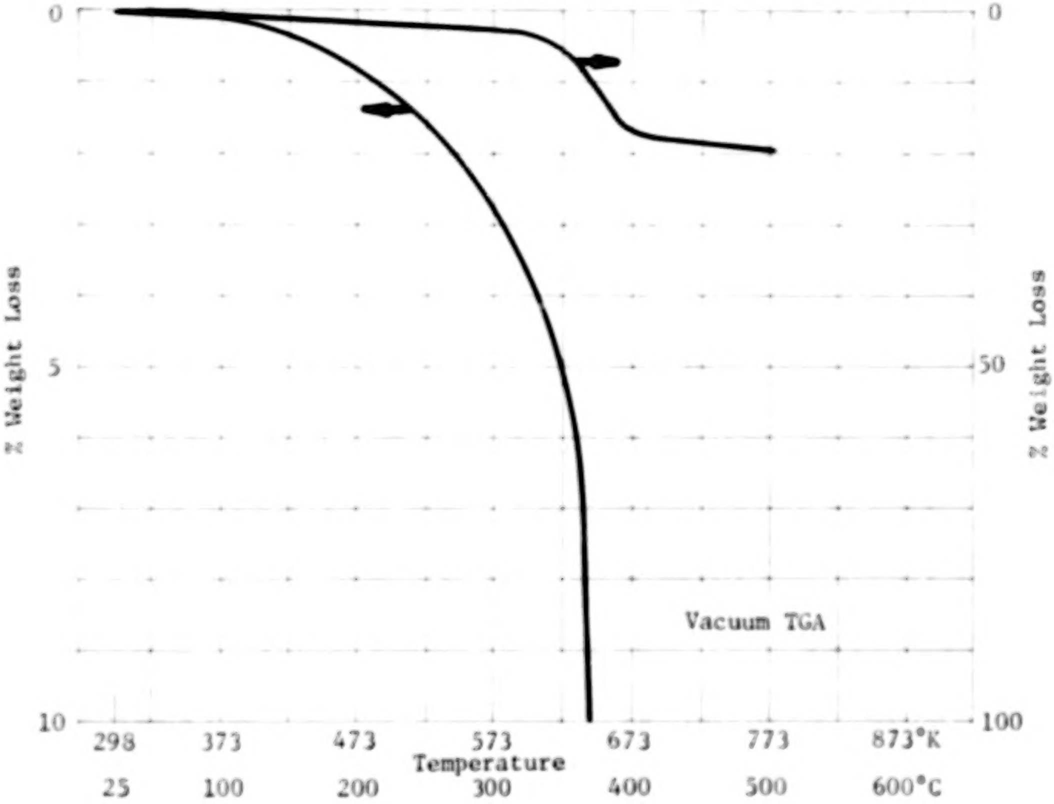
240							

Epotek 417

Chemical Characterization Summary

Mix Ratio: **15 pbw of Resin to 1 pbw of Hardener**
Cure: **1 hr. at 383°K (105°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **423°K (150°C)-563°K (290°C)**

a_o = **2%** of initial weight

$$k = 1.3\times10^5 \exp\left(\frac{-13300}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**5.2×10^3**	
373°K (100°C)	**3.2×10^2**	
423°K (150°C)	**37**	

Number and Relative Peak Intensity

Temperature, °K (°C)

Epotek 417

m/e	298(25)	523 (250)	623 (350)	673 (400)	773 (500)		
14	993	1010	1393	1109	1161		
15	389	502	1761	1127	1068		
16	3443	3173	3635	2977	3190		
17	10160	8113	9371	7637	7172		
18	31594	23709	27951	21620	19856		
19	117	121	181	130	93		
20	201	161	203	162	176		
21							
22							
23							
24			59		72		
25		53	218	101	180		
26	111	230	1031	581	623		
27	303	544	2035	1368	867		
28	8225	8581	10114	8941	9190		
29	263	561	2618	1212	752		
30	830	896	924	940	852		
31	161	289	711	570	477		
32	2823	2635	2540	2419	2446		
33			45				
34							
35							
36			88	61			
37		46	545	349	88		
38		67	1027	704	147		
39		216	2943	2192	442		
40	1236	1281	1696	1724	1307		
41	51	187	765	497	290		
42	45	203	623	304	174		
43	81	173	1333	690	236		
44	612	821	2530	875	743		
45		70	169	107	55		
46			53	52			
47			140	122			
48			42				
49			178	126	45		
50		55	1073	612	141		
51		67	1385	866	167		
52		50	634	321	84		
53		47	879	502	88		
54			254	131	46		
55		60	536	442	101		
56		64	167	116	89		
57		44	234	110	56		
58			141	63			
59				51			
60			64	67			
61			216	167	43		
62			380	302	52		
63			796	619	95		
64			248	200	47		
65		49	1191	1061	132		
66		40	1235	1038	112		
67			150	140			
68			121	86			
69			63	44			
70			44				
71							
72			60				
73			88	55			
74			247	174			
75			124	114			
76			121	88			
77		58	1965	872	130		
78		40	586	286	83		
79			1286	484	85		
80			487	145			
81			121	60			
82			59				
83							
84		47	65	44	41		
85							
86		42	50				
87			40				
88							
89			360	188			
90			597	195			
91		40	560	542	123		
92			114	105	44		
93			132	134	40		
94			1880	1456	110		
95			156	114			
96							
97							
98							
99							
100							
101							
102							
103			59	133			
104				47			
105			87	101			
106			54	51			
107			1498	585	62		
108			1738	437	70		
109			149	50			
110							
111							
112							
113							
114							
115			46	63			
116							
117							
118			41	41			
119			56	201			
120				68			
121			104	388			
122			43	85			
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Epotek 417

m/e	298 (25)	523 (250)	623 (350)	673 (400)	773 (500)		
128							
129	42	52	40	41			
130							
131			67	62			
132	41		64	49			
133			44	51			
134			59	167			
135				40			
136				76			
137							
138							
139							
140							
141							
142							
143							
144							
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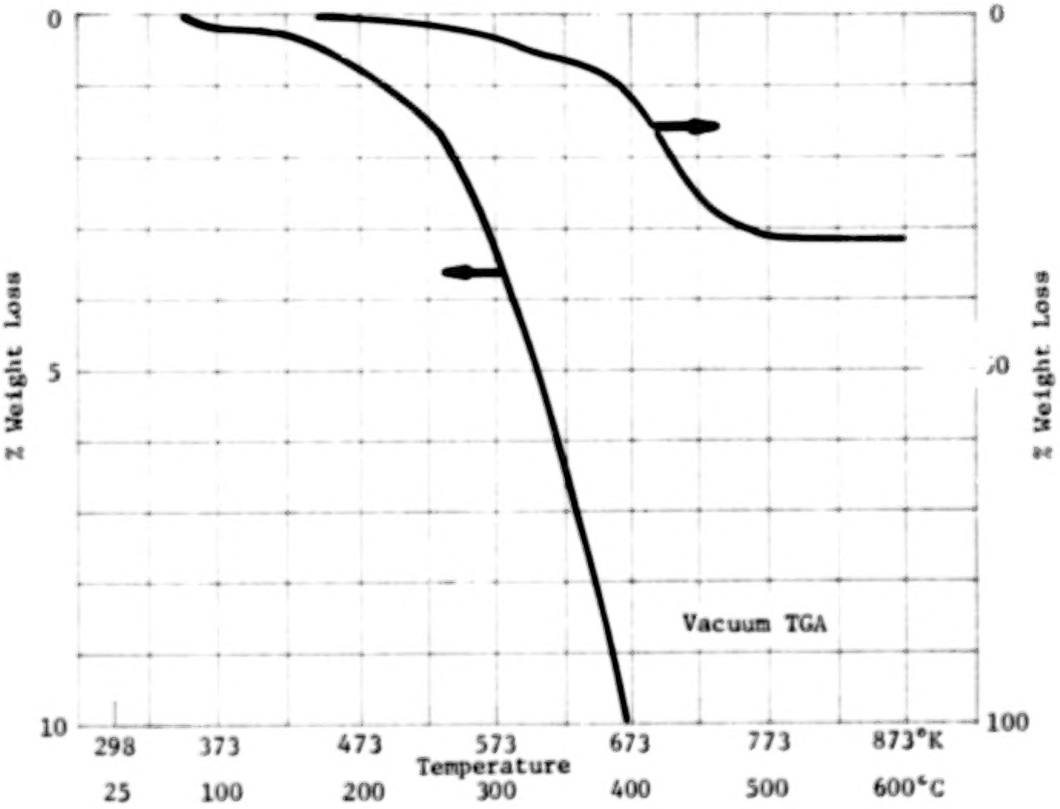
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **423°K (150°C)-773°K (500°C)**

a_o = **30.6%** of initial weight

$$k = 4.0\text{x}10^{1} \ \exp\left(\frac{-\ 9000}{1.98\ T°K}\right) \ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	1.8×10^4	
373°K (100°C)	2.8×10^3	
423°K (150°C)	6.7×10^2	

Number and Relative Peak Intensity

Temperature, °K (°C) Epoxy 450 Tubing

m/e	298 (25)	423 (150)	573 (300)	673 (400)	823 (550)		
14	1986	1969	2340	3228	2276		
15	653	688	1413	3105	1774		
16	4097	4627	4893	6817	5174		
17	10998	16346	15097	16108	13374		
18	63593	53884	49664	52757	41603		
19	576	630	620	748	461		
20	371	364	400	564	474		
21							
22							
23							
24				196			
25			242	1136	199		
26	305	332	1737	5838	1531		
27	467	501	3229	9722	2373		
28	24011	23223	27134	62265	26822		
29	295	326	3970	11578	2352		
30	263	320	1290	3015	703		
31	150	135	929	1920	666		
32	5053	5479	5262	5038	4933		
33							
34							
35							
36				70			
37			301	794	91		
38			266	1241	229		
39			1015	6756	1049		
40	3249	3103	3693	5506	3795		
41		40	3187	10444	2571		
42			539	2572	606		
43	40	59	3465	8603	1105		
44	574	680	1901	13001	1453		
45			378	1296	190		
46							
47							
48							
49				134			
50			83	760	190		
51			61	590	215		
52			44	263	65		
53			84	1043	426		
54				470	68		
55			956	4572	1161		
56			1148	4836	852		
57			386	2256	521		
58				441	72		
59							
60				144			
61							
62							
63				71			
64							
65				273	74		
66				335	40		
67				723	404		
68				450	207		
69				526	152		
70				271	61		
71			84	346	65		
72			620	1592			
73			191	624			
74				47			
75							
76							
77				121	52		
78				83	45		
79				115	43		
80							
81				80			
82				45			
83				128			
84	62		76	291	89		
85							
86				105			
87							
88							
89							
90							
91				76	75		
92							
93							
94				351			
95							
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97							
98				90			
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127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Epoxy 450 Tubing

m/e	298 (25)	423 (150)	573 (300)	673 (400)	823 (550)		
128							
129			42	81	45		
130							
131				43			
132				54			
133							
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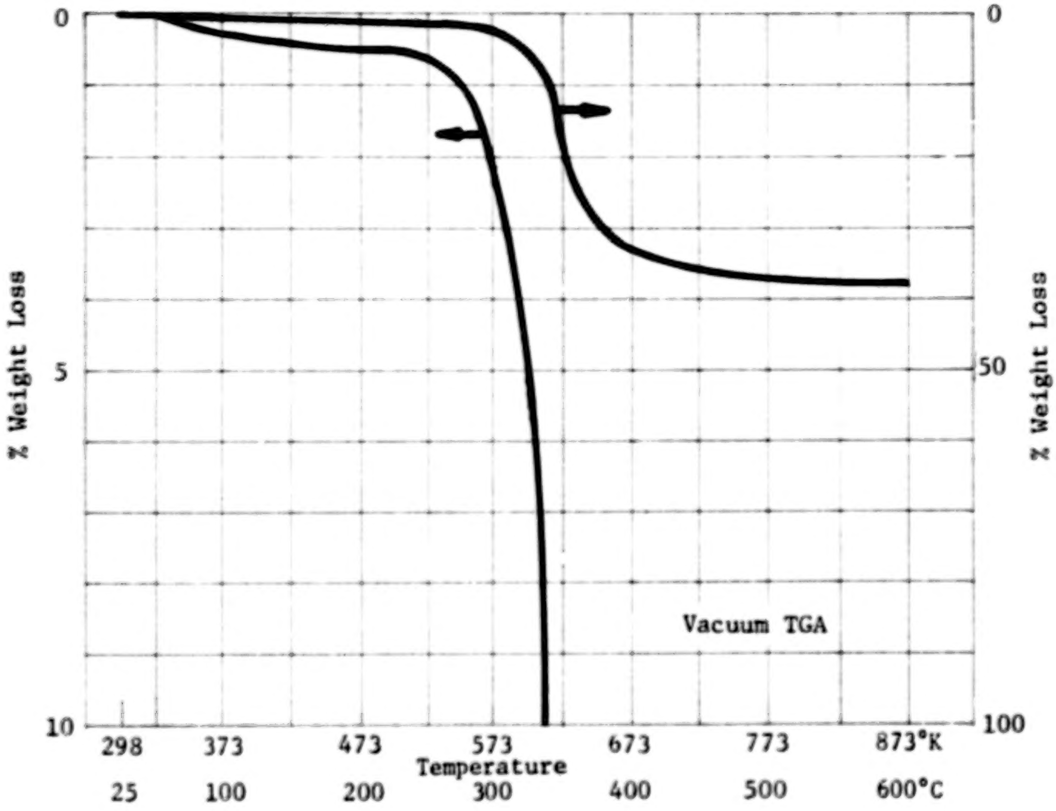
Chemical Characterization Summary

Mix Ratio: **Not available**
Cure: **Not available**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **413°K (140°C)-753°K (480°C)**

a_o = **35%** of initial weight

$$k = 4.5\times10^{11} \exp\left(\frac{-\ 39000}{1.98\ T^{\circ}K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.5×10^{11}	
373°K (100°C)	1.2×10^{8}	
423°K (150°C)	5.0×10^{5}	

Number and Relative Peak Intensity

Temperature, °K (°C)

ES-222

m/e	298(25)	473(200)	623 (350)	723 (450)	823 (550)		
14	2324	2530	6028	2866	3349		
15	374	546	10904	2120	3935		
16	3734	3984	11432	5106	7519		
17	14353	14292	26078	12146	11703		
18	47655	46583	75459	37776	36263		
19	1349	1305	1298	603	517		
20	326	325	591	364	359		
21							
22							
23							
24			1067	68	64		
25	45	68	3892	377	305		
26	271	452	19003	2130	1768		
27			20014				
28	26092	26778	51125	27361	27466		
29	319	614	9369	1342	945		
30	695	728	6738	1155	1083		
31	62	67	2684		109		
32	6443	6135	5923	5371	5356		
33							
34							
35							
36				40			
37			5081	239	84		
38			9894	500	195		
39		50	31971	2066	838		
40	984	996	13247	1580	1255		
41	44	61	7137	932	399		
42	40	51	7606	550	255		
43	65	124	5831	601	284		
44	774	991	7340	873	697		
45			1570	81	58		
46			482				
47			1477				
48			281				
49			1613	73			
50			7732	516	207		
51			9384	695	270		
52			3771	240	111		
53			5685	355	102		
54			1400	85	41		
55			5464	263	79		
56			1647	92	45		
57			732	57			
58			1123	49			
59			555				
60			488				
61			1575	54			
62			2944	118	44		
63			5997	311	104		
64			2054	99	50		
65			13448	542	179		
66			14418	491	153		
67			2546	89	41		
68			831	46			
69			187				
70			217				
71			164				
72			134				
73			449				
74			1366	48			
75			891				
76			607				
77			6201	547	172		
78			1849	138	67		
79			2684	217	69		
80			1147	71			
81			422				
82			154				
83			59				
84			115	47			
85			75				
86			118				
87			117				
88							
89			910	51			
90			496	45			
91			5030	350	161		
92			711	44			
93			1139	48			
94			15669	437	100		
95			1218				
96			76				
97							
98			44				
99							
100							
101			70				
102			131				
103			977	50			
104			102				
105			602	45			
106			123				
107			2761	295	69		
108			195	100	49		
109			104				
110							
111							
112							
113							
114							
115			49				
116			264				
117			94				
118			638				
119				54			
120			275				
121			2356	97			
122			402	41			
123							
124							
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127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) ES-222

m/e	298 (25)	473 (200)	623 (350)	723 (450)	823 (550)		
128							
129							
130							
131							
132			63				
133			67				
134			547				
135			834				
136			92				
137			117				
138							
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143							
144							
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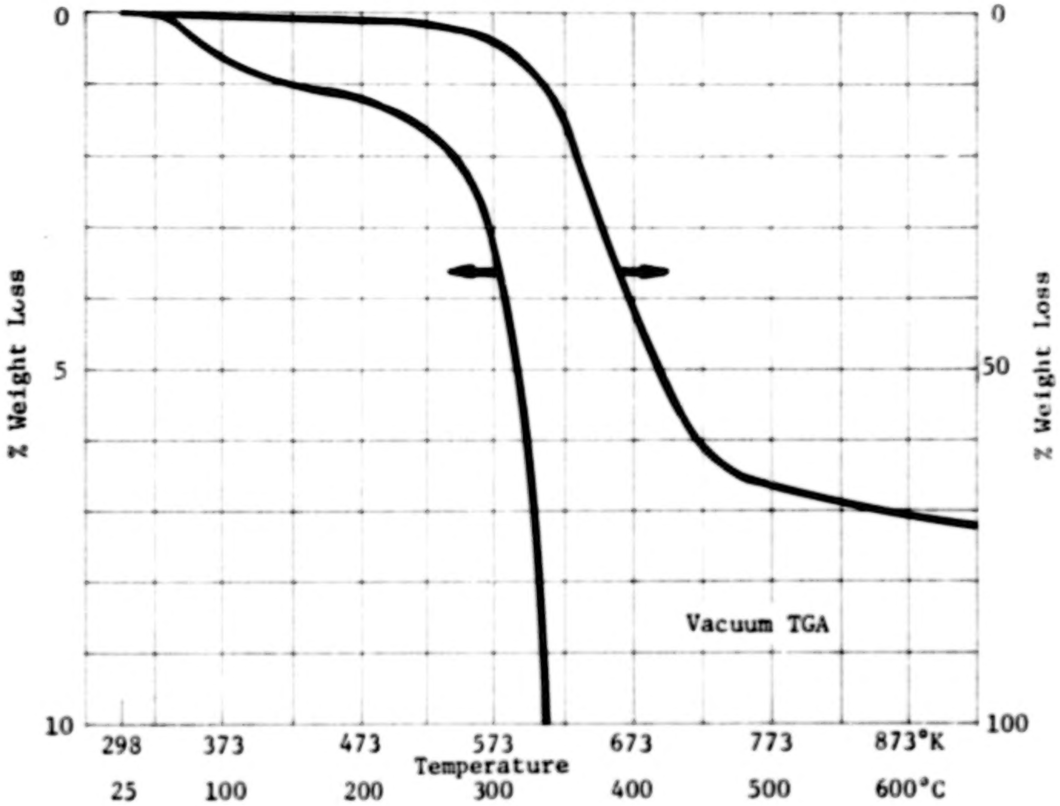
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **1 hr. at 450°K (177°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **453°K (180°C)-673°K (400°C)**

a_o = **59%** of initial weight

$$k = 8.2 \times 10^{8} \exp\left(\frac{-28600}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**2×10^{10}**	
373°K (100°C)	**5×10^{7}**	
423°K (150°C)	**4.8×10^{5}**	

Isothermal weight loss in nitrogen - 1.23%

Number and Relative Peak Intensity

Temperature, °K (°C) FM-40

m/e	298(25)	523 (250)	673 (400)	773 (500)	923 (650)		
14	270	3750	853	5814	6230		
15	64	2675	1806	11581	13981		
16	1064	16797	2988	21140	26318		
17	3162	34018	5912	28033	30740		
18	9727	84673	16428	75686	83260		
19		506		344	197		
20		736	52	827	816		
21							
22		50					
23							
24		41	65	472	105		
25		148	413	1822	482		
26		1194	2184	9120	2736		
27	73	2574	2761	11350	4256		
28	4349	43520	9085	54613	56833		
29		1137	2199	5096	2121		
30	143	2510	963	3807	2650		
31		121	605	644	268		
32	945	9088	933	8167	8497		
33				152	46		
34				313	125		
35							
36			45	290	76		
37		43	710	1994	236		
38		113	1407	3876	456		
39		326	4693	12495	1416		
40	630	7136	2321	10723	8154		
41		372	1462	3500	983		
42		356	1011	1979	695		
43		621	1920	2712	1308		
44	175	8669	4896	4879	5056		
45		125	274	561	227		
46				160			
47			164	398			
48		61		251			
49			245	923	99		
50		137	1391	4714	551		
51		101	1725	6468	675		
52		107	682	2653	370		
53			1058	3841	259		
54		41	260	910	126		
55		61	871	2078	429		
56		42	178	396	198		
57			111	226	82		
58			152	204	61		
59				101			
60			93	357			
61			229	837	47		
62			466	1545	91		
63			963	3285	246		
64		105	296	1150	114		
65		52	1979	4911	390		
66		85	2253	4876	399		
67			332	747	127		
68			152	380	64		
69			171	122			
70			119	80			
71				50			
72				129			
73			42	225			
74			227	900	68		
75			100	531	58		
76			77	475	48		
77			1644	6679	414		
78		64	527	2423	585		
79			953	4550	189		
80			347	1439	48		
81			117	394			
82				108			
83				54			
84		114		181	169		
85				60			
86				147			
87				101			
88							
89			156	971			
90			216	1312			
91			730	3545	350		
92			119	761	109		
93			219	580			
94			2964	5718	385		
95			228	396			
96				44			
97							
98							
99							
100							
101							
102				128			
103			93	508			
104				218			
105			125	811			
106				463			
107			1633	7399	200		
108			974	4712	115		
109			49	314			
110							
111							
112							
113							
114							
115				335			
116				82			
117				180			
118				96			
119			61	195			
120				157			
121			510	1630	52		
122			224	1584			
123				90			
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) PM-44

m/e	298 (25)	523 (250)	673 (400)	773 (500)	923 (650)		
128				51			
129		118		176	135		
130							
131		67		207	105		
132		109		212	147		
133							
134				81			
135				115			
136				182			
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145				120			
146							
147				78			
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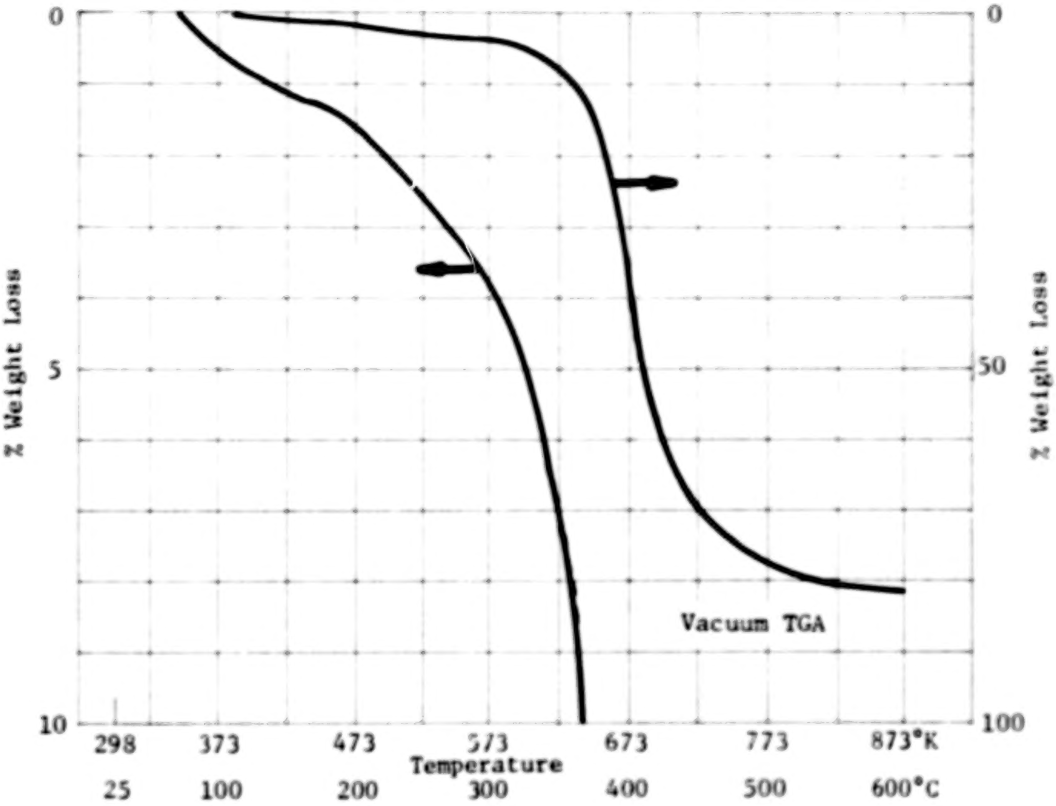
Chemical Characterization Summary

Mix Ratio: **One Component**
Cure: **2 hrs. at 448°K (175°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C) - 773°K (500°C)**

a_o **= 79.6% of initial weight**

$$k = 2.2 \times 10^{13} \exp\left(\frac{-42{,}000}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	9.8×10^{14}	
373°K (100°C)	1.5×10^{11}	
423°K (150°C)	1.7×10^{8}	

Number and Relative Peak Intensity

Temperature, °K (°C) PM-[illegible] Suggested File

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
14	3006	2967	3208	7715	6027	4732	
15	1786	1628	2318	12763	10694	8852	
16	10661	10771	15232	37670	19376	18075	
17	31060	29555	32897	64202	33565	26605	
18	94091	87618	79808	101305	86051	70783	
19	262	260	234	305	304	63	
20	536	478	473	794	513	418	
21							
22				600			
23							
24				638	530	72	
25			76	2036	2348	585	
26	388	511	816	10216	13029	3785	
27	946	1092	1499	12475	10512	5036	
28	27493	27455	28234	65966	51175	35514	
29	1742	1625	1754	9636	10526	3262	
30	2821	2989	2973	9185	7830	3648	
31	1474	1323	1288	3653	2596	1449	
32	9026	8732	8351	9517	9481	7744	
33				47			
34							
35				83			
36				356	319		
37				1805	2840	595	
38				3426	5718	1319	
39		136	197	9761	20104	4367	
40	4404	4422	4535	10459	10530	5765	
41	59	117	163	4826	9134	1238	
42	52	72	150	9921	5368	744	
43	147	182	361	8104	7360	1038	
44	1893	2106	5189	75259	10254	2865	
45			67	4594	628	113	
46				380	160		
47				386	389		
48				116	74		
49				770	1118	173	
50				3618	6179	1626	
51			41	3032	8270	2092	
52				2722	3551	807	
53				1809	5334	1110	
54				1055	1784	197	
55				1925	5808	614	
56				1589	2021	126	
57				797	751		
58				1816	584		
59				795	201		
60				1348	452		
61				435	1024	168	
62				680	2007	436	
63				1350	4480	1105	
64				687	1261	200	
65				3207	6827	1586	
66				4377	6250	1467	
67				1180	1902	114	
68				526	803	60	
69				203	466		
70				154	312		
71				145	78		
72				52	90		
73				173	258		
74				288	1019	156	
75				163	605	43	
76				152	531	53	
77				863	8494	1860	
78				920	2737	723	
79				1335	5255	1195	
80				1023	1644	266	
81				657	698		
82				172	321		
83				67	154		
84				230	505		
85					76		
86					90		
87					78		
88							
89				78	1057	186	
90				73	1314	259	
91		76	41	374	4521	1819	
92				428	833	412	
93				1098	958	59	
94				6816	8360	1967	
95				695	676		
96					76		
97				43			
98							
99							
100							
101							
102					114		
103					732		
104					222		
105				57	850	262	
106				177	356	191	
107				593	9394	1924	
108				1342	5095	1206	
109				220	328		
110							
111							
112							
113							
114							
115					406		
116					47		
117					195		
118				98	98		
119				67	555		
120				50	210		
121				91	3435		
122				193	1987	150	
123					60		
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) PH-Hm Supported Film

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
128							
129				68	65		
130							
131				89	268		
132				94	130		
133					79		
134				64	223		
135					305		
136					443		
137							
138							
139							
140							
141							
142							
143							
144							
145					69		
146							
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TABLE I
LAP SHEAR TEST SUMMARY FOR (ASTM D1002)

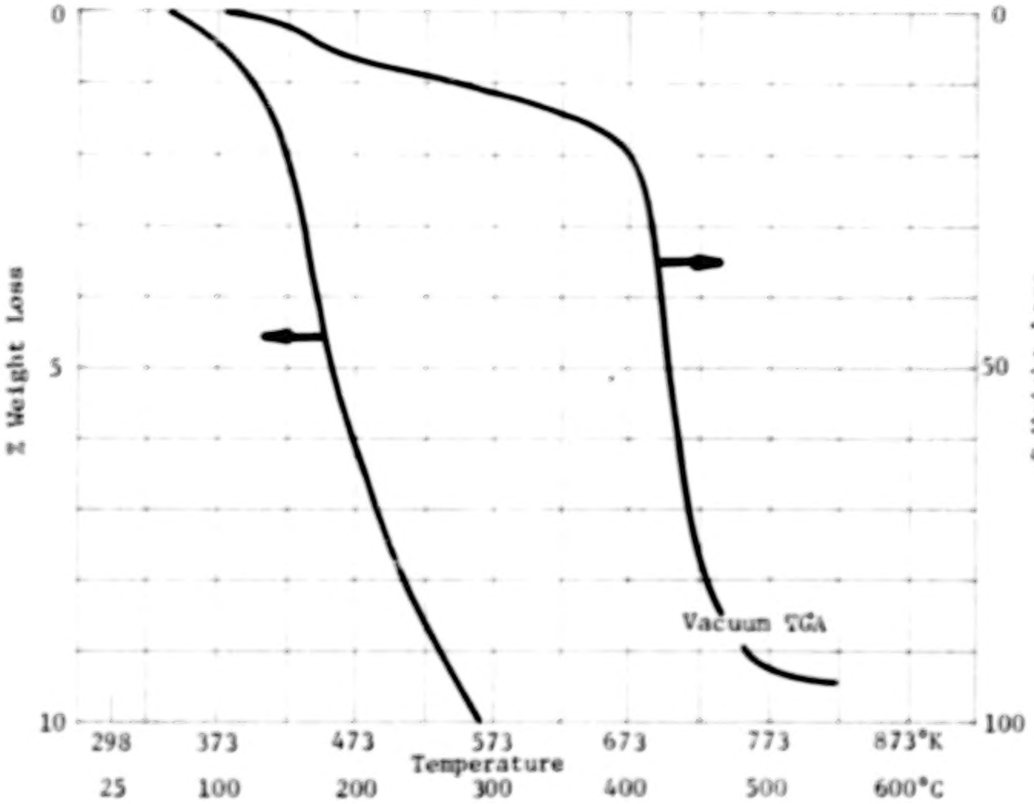
EXPOSURE	TEST CONDITION	LAP SHEAR STRENGTH, Pa x 10^{-7} (PSI)		
		High	Low	Average
Ambient Air	298°K (25°C), air	2.38 (3450)	2.21 (3200)	2.27 (3290
Heat Compatibility 380 hours at 408°K (135°C)	298°K (25°C), air	2.50 (3630)	2.19 (3170)	2.37 (3430)
Heat Compatibility 1 month thermal vacuum at 338°K (65°C)	298°K (25°C), in-situ vacuum	2.50 (3620)	2.28 (3300)	2.36 (3420)

Chemical Characterization Summary

Mix Ratio: **One component**

Cure: **12 hrs. at 398°K (125°C),**
2 hrs. at 423°K (150°C)

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **393°K (120°C) - 573°K (300°C)**

a_o = **10.8%** of initial weight

$$k = 3.3 \times 10^9 \exp\left(\frac{-20{,}900}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**2.7×10^4**	
373°K (100°C)	**3.4×10^2**	
423°K (150°C)	**12**	

Number and Relative Peak Intensity

Temperature, °K (°C) High Temp. 221

m/e	298 (25)	473 (200)	573 (300)	673 (400)	748 (475)	823 (550)	
14	1674	1541	2915	5059	4219	2670	
15	527	719	2492	8610	9167	4939	
16	5868	4927	5884	14658	11374	10627	
17	24222	21084	19309	37896	24005	18126	
18	81059	66774	67673	150902	70226	61985	
19	93	125	248	435	261	75	
20	530	478	517	916	763	644	
21							
22				231			
23							
24			148	1150	637	115	
25		109	961	4780	2723	692	
26	299	823	5760	22117	15071	3087	
27	816	1841	9590	30828	29604	5899	
28	27716	27198	33647	100917	62726	37723	
29	316	1226	6931	24219	20789	3037	
30	1078	1219	1735	3984	3688	2050	
31		3759	9561	4254	1127	279	
32	6456	5896	5687	6164	5936	5801	
33				59	49		
34							
35				86	42		
36			158	1205	713	211	
37		44	606	4265	3084	239	
38		86	616	6366	6063	656	
39	117	349	2604	17651	29054	3127	
40	6297	6270	6832	15070	16260	7767	
41	76	372	2444	10070	29266	2488	
42	53	452	2230	7734	12479	1120	
43	106	423	7138	20292	21431	1977	
44	1004	1320	4351	45360	6779	2503	
45		67	539	7985	2943	611	
46				470	312	53	
47				762	409		
48				306	317		
49			73	969	1191	91	
50			265	4002	9659	755	
51			112	4070	7655	968	
52			80	1706	2966	305	
53			257	2894	5801	516	
54			135	1036	2719	276	
55			1568	9660	13352	1321	
56		46	2521	7961	6320	404	
57			660	2910	5564	536	
58			801	3022	1807	72	
59		167	630	380	581	49	
60		129	529	4476	4923	678	
61			91	867	1332	119	
62				7298	1561	110	
63			46	2646	4087	452	
64				781	1119	82	
65			83	5737	6241	624	
66			39	7324	5099	319	
67			61	1345	4216	212	
68			68	554	1895	140	
69				486	2640	230	
70				367	2195	106	
71				237	1373	47	
72				183	405		
73				633	2519	612	
74				1019	1136	135	
75				391	597	54	
76				361	531	62	
77				2170	6147	737	
78				1115	1919	295	
79				1052	3828	304	
80				191	907	56	
81				189	1352	54	
82				139	770	65	
83				115	766	65	
84				176	777	67	
85				127	513	61	
86				90	232		
87				87	428		
88					43		
89				438	743	71	
90				401	726	51	
91				1284	4729	1153	
92				386	788	172	
93				45	735	43	
94			111	9695	4905	261	
95				560	643		
96				120	279		
97				40	232		
98				70	428		
99					61		
100					48		
101				41	159		
102				105	222		
103				280	691	87	
104				60	222		
105				191	1312	269	
106				41	208	64	
107				1008	3337	265	
108				494	1365	93	
109					105		
110					53		
111							
112					48		
113							
114					50		
115				182	926	81	
116				41	140		
117				62	438	61	
118				195	143		
119				380	1118	79	
120				68	281	66	
121				362	1881	87	
122				109	468		
123					44		
124							
125							
126							
127					59		

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

High Temp. 201

m/e				673 (400)	748 (475)	823 (550)	
128				209			
129			41	199			
130				56			
131			697	400			
132			323	172			
133			101	482			
134			365	557			
135			43	526			
136			79	385			
137							
138							
139							
140							
141				104			
142				65			
143				67			
144							
145			56	180			
146				56			
147				130			
148				72			
149				93			
150				43			
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158				61			
159				99			
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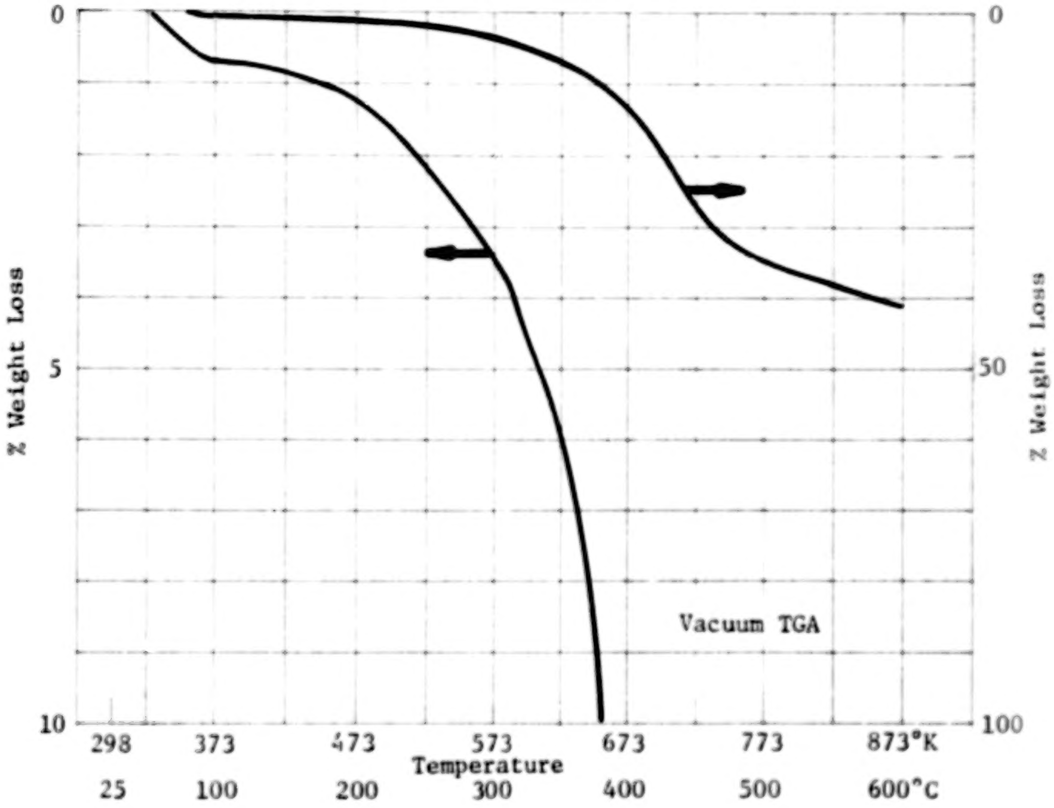
Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **1 hr. at 444°K (171°C), vacuum bag**

1. TGA Preconditioning: **100 hrs. at 398°K (125°C) in N_2 atmosphere**



2. Activation Energy of Decomposition:

Over the Range: **649°K (376°C)-973°K(700°C)**

a_o = **42%** of initial weight

$$k = 1.7\times10^{12} \exp\left(\frac{-41600}{1.98\ T^\circ K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec In Vac	In Nitrogen
323°K (50°C)	**6.3×10^{15}**	
373°K (100°C)	**1.0×10^{12}**	
423°K (150°C)	**1.3×10^{9}**	

Number and Relative Peak Intensity

Temperature, °K (°C) HT 435 Film Adhesive

m/e	298 (25)	523 (250)	623 (350)	723 (450)	823 (550)		
14	688	1093	1476	1812	2063		
15	187	633	1609	3376	6191		
16	4118	8660	11092	6911	11356		
17	15583	17885	20859	14876	14074		
18	52672	42526	50595	44380	42985		
19	47	69	66	119	62		
20	116	107	162	164	158		
21							
22			61				
23							
24				150	69		
25			70	727	282		
26	68	204	812	5367	2869		
27	228	734	2078	7561	3915		
28	16133	17794	25694	25847	25382		
29	176	541	1840	2856	1339		
30	763	1055	1530	1360	1260		
31		194	159	361	191		
32	4295	4034	4093	3928	3850		
33				63			
34							
35					40		
36				88			
37			42	1483	472		
38			88	3184	1197		
39			245	11960	490		
40	1394	1679	2209	5688	3410		
41			428	1920	463		
42			491	710	213		
43	40	489	2379	2375	473		
44	511	2909	16748	2281	1625		
45		81	112	156			
46			44	91	65		
47				341	131		
48				57	179		
49				458			
50			51	3618	1393		
51			68	4950	2117		
52			45	1730	574		
53				2887	1019		
54				424	142		
55			45	1738	439		
56			80	91	48		
57		50	133	75			
58				103	47		
59				70			
60				118	61		
61				397	164		
62				847	251		
63				2211	837		
64				454	155		
65			48	4248	1667		
66			46	4524	1678		
67				235	75		
68				123	69		
69				47			
70							
71							
72							
73				86	58		
74				315	99		
75				122	68		
76				128	70		
77				4091	1468		
78				1006	384		
79				2294	796		
80				489	188		
81				74			
82							
83							
84							
85							
86							
87							
88							
89				169	113		
90				363	140		
91				901	800		
92				114	196		
93				81			
94			48	3364	1375		
95				94			
96							
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102							
103				43			
104							
105					43		
106					47		
107				669	174		
108				352	179		
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TABLE 1 LAP SHEAR STRENGTH (ASTM D1002)

	Ultimate Strength Pa x 10^{-7} (PSI)			
Exposure	High	Low	Average	No. Specs.
Baseline	1.66 (2400)	1.54 (2230)	1.63 (2360)	5
Heat Compatibility (1)	1.63 (2360)	1.50 (2170)	1.61 (2330)	5
Heat Compatibility, One Month Thermal Vacuum (1) (2)	1.52 (2200)	1.31 (1900)	1.45 (2100)	5
Heat Compatibility, Three Months Thermal Vacuum (1) (3)	1.57 (2275)	1.32 (1920)	1.50 (2180)	5
Heat Compatibility, Seven Months Thermal Vacuum (1) (4)	1.04 (1500)	.90 (1300)	1.13 (1640)	5

(1) Heat compatibility - 379 hours at $408^{\circ}K$ ($135^{\circ}C$) in N_2 atmosphere.

(2) Thermal vacuum - tested at 1×10^{-5} torr after 30 days at $338^{\circ}K$ ($65^{\circ}C$) and 1×10^{-6} torr.

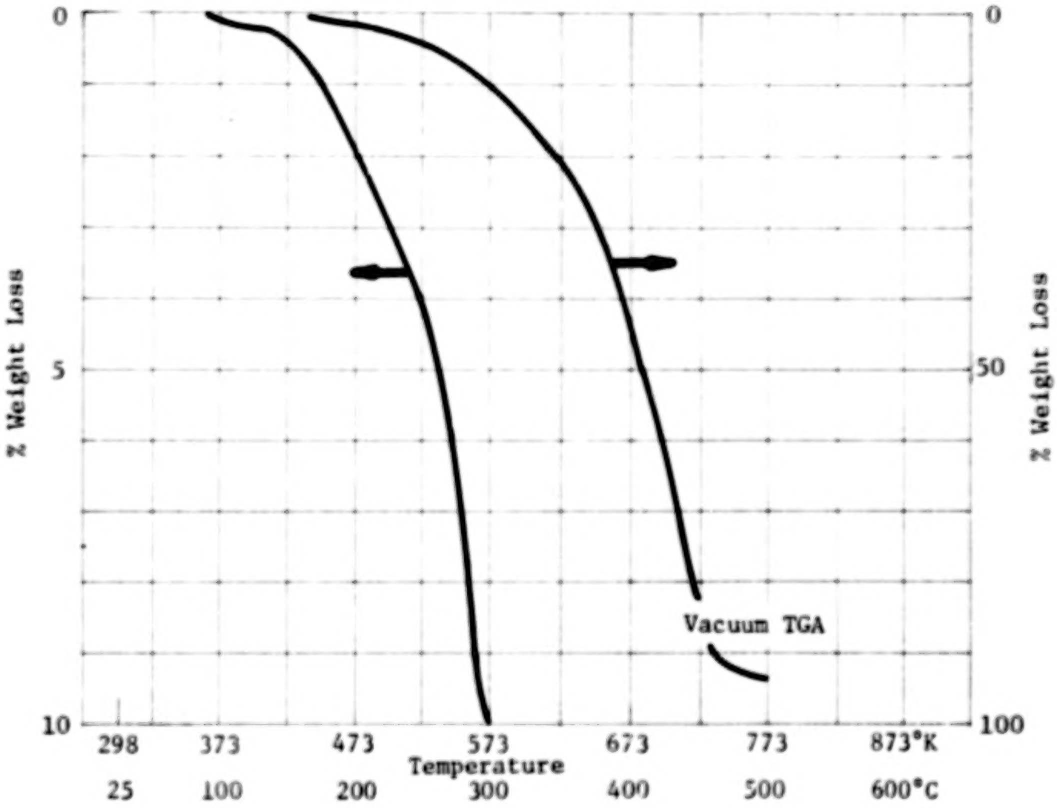
(3) Same as Note (2), except exposure is 90 days.

(4) Same as Note (2), except exposure is 210 days.

Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **4 hrs. at 311°K (38°C), 4 hrs. at 477°K (204°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **448°K (175°C)-748°K (475°C)**

a_o **= 91.7% of initial weight**

$$k = 5.39\text{x}10^3 \exp\left(\frac{-14600}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**8.8 x 10^5**	
373°K (100°C)	**4.1 x 10^4**	
423°K (150°C)	**4.0 x 10^3**	

Number and Relative Peak Intensity

Temperature, °K (°C) Hysol AS-7-4315

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	1001	992	1523	2610	1455		
15	403	417	1660	4246	1695		
16	3399	3194	3769	5802	4153		
17	10767	8772	8664	11015	8004		
18	32691	25961	25498	32351	22171		
19	115	90	342	340	106		
20	250	215	241	298	246		
21							
22				105			
23							
24			135	325	86		
25	47	44	438	1261	281		
26	203	216	2229	6076	1290		
27	397	437	2696	8105	1707		
28	9536	9499	14634	27593	12145		
29	186	202	3867	6923	1162		
30	779	758	1670	1886	993		
31	71		1170	1397	213		
32	2826	2657	2646	2707	2481		
33			62	69			
34							
35							
36			105	381	68		
37			501	2685	302		
38			626	3594	491		
39		71	1107	6820	1371		
40	1753	1758	2093	4055	2235		
41	62	59	765	4866	593		
42	57	54	757	3062	360		
43	80	90	1736	5966	691		
44	705	768	2949	10634	1304		
45			2235	1067	171		
46			82	135			
47				252	53		
48			46	177			
49			199	1119	136		
50			1069	6500	693		
51			367	1629	565		
52			161	926	254		
53			177	1193	291		
54			90	388	82		
55			606	7313	340		
56			326	2790	134		
57			819	1126	110		
58			631	1030	111		
59			54	102			
60			41	291	58		
61			173	570	100		
62			50	587	175		
63			67	889	360		
64	44		45	297	126		
65			54	1793	515		
66	45		64	2220	443		
67			45	428	86		
68				208	49		
69				128			
70				76			
71				59			
72			52	140			
73			114	362	64		
74			343	1891	172		
75			195	1028	126		
76			1153	5819	239		
77			156	1233	526		
78			63	417	230		
79				328	235		
80				100	57		
81				88			
82				88			
83				145			
84	62		136	1725	71		
85				161			
86				62	42		
87				53			
88							
89				151			
90				133	95		
91				388	490		
92				87	105		
93				132	57		
94				3266	511		
95				300	63		
96				81			
97							
98							
99							
100							
101							
102				53			
103				147	106		
104			763	3571	211		
105			77	393	250		
106				63	85		
107				405	388		
108				196	173		
109							
110							
111							
112							
113							
114							
115				86	63		
116							
117				51	56		
118				72	40		
119				99	114		
120					68		
121				105	171		
122				47	66		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (75)	473 (200)	573 (300)	673 (400)	773 (500)		
128							
129	63	40	53	68	57		
130							
131	49		44	135	79		
132	58		51	97	66		
133				47			
134				94	67		
135				185	57		
136				51	44		
137							
138							
139							
140							
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142							
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144							
145							
146							
147							
148			64	197			
149							
150							
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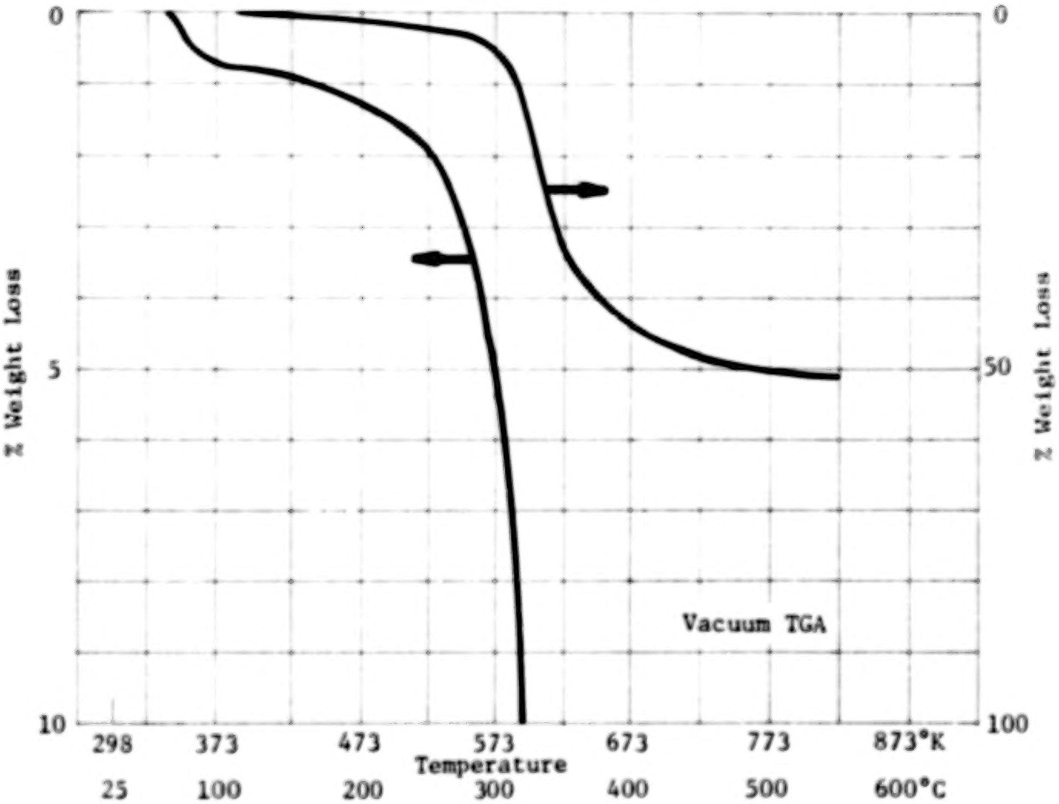
Chemical Characterization Summary

Mix Ratio: **100 pbw C9 to 30 pbw H2**
Cure: **24 hrs. at room temperature**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **423°K (150°C) - 723°K (450°C)**

a_o = **50.5%** of initial weight

$$k = 1.32 \times 10^{12} \exp\left(\frac{-35,700}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**7.4×10^{11}**	
373°K (100°C)	**4.2×10^{8}**	
423°K (150°C)	**1.4×10^{6}**	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	573 (300)	623 (350)	723 (450)	823 (550)	
14	130	107	464	368	314	322	
15			869	1202	500	665	
16	601	460	677	1279	776	1130	
17	3737	2759	4795	5197	2670	2703	
18	14760	11333	16316	19088	11143	10164	
19	60	46	61	158	50	41	
20	48		63	96	48		
21							
22							
23							
24			62	127			
25			226	580	200	117	
26	59	73	982	2677	1016	675	
27	79	85	1085	3183	1394	609	
28	2243	2102	4462	6175	4261	3665	
29	75	94	2423	3390	1120	656	
30			320	1262	282	160	
31			220	1187	255	121	
32	701	556	688	701	638	634	
33				55			
34							
35							
36			53	96			
37			155	624	223	72	
38			222	1127	426	360	
39	64	72	795	3890	1634	610	
40	257	254	630	1853	783	560	
41	69	81	846	2648	876	460	
42			971	2805	471	276	
43	70	81	1392	1979	670	365	
44	701	215	1906	2321	660	696	
45			345	1586	221	183	
46				88			
47				130			
48							
49			63	206	83		
50			421	898	912	201	
51			156	964	677	230	
52			193	566	270	105	
53			120	599	453	165	
54			100	460	136	57	
55			256	842	371	156	
56			269	926	173	113	
57			214	440	144	113	
58			219	540	76	48	
59			46	308	49		
60			93	114	40		
61				172	74		
62				300	145	59	
63			41	592	416	130	
64				233	132		
65			95	1415	663	170	
66			93	1601	507	103	
67			82	364	149	57	
68			164	469	92		
69			65	170			
70			52	309			
71			52	166			
72				109			
73				186	50		
74				176	109		
75				221	64		
76				139	64		
77			54	482	706	160	
78				265	251	92	
79			67	397	375	104	
80			41	260	137		
81				114	60		
82				125			
83				61			
84				101			
85				63			
86							
87							
88							
89				84	125		
90				49			
91				410	492	287	
92				130	93	55	
93							
94			128	2340	677	117	
95				241	77		
96				49			
97							
98							
99							
100							
101							
102							
103				55	81		
104							
105				86	104	54	
106				79			
107				226	538	111	
108				274	260	40	
109				73			
110							
111							
112							
113							
114							
115				45			
116				49	82		
117					40		
118							
119							
120				283	149		
121				80			
122				95	253	40	
123					89		
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e				623 (350)	723 (450)	823 (550)	
128							
129							
130							
131					56		
132							
133							
134				71	63		
135				276	95		
136					66		
137							
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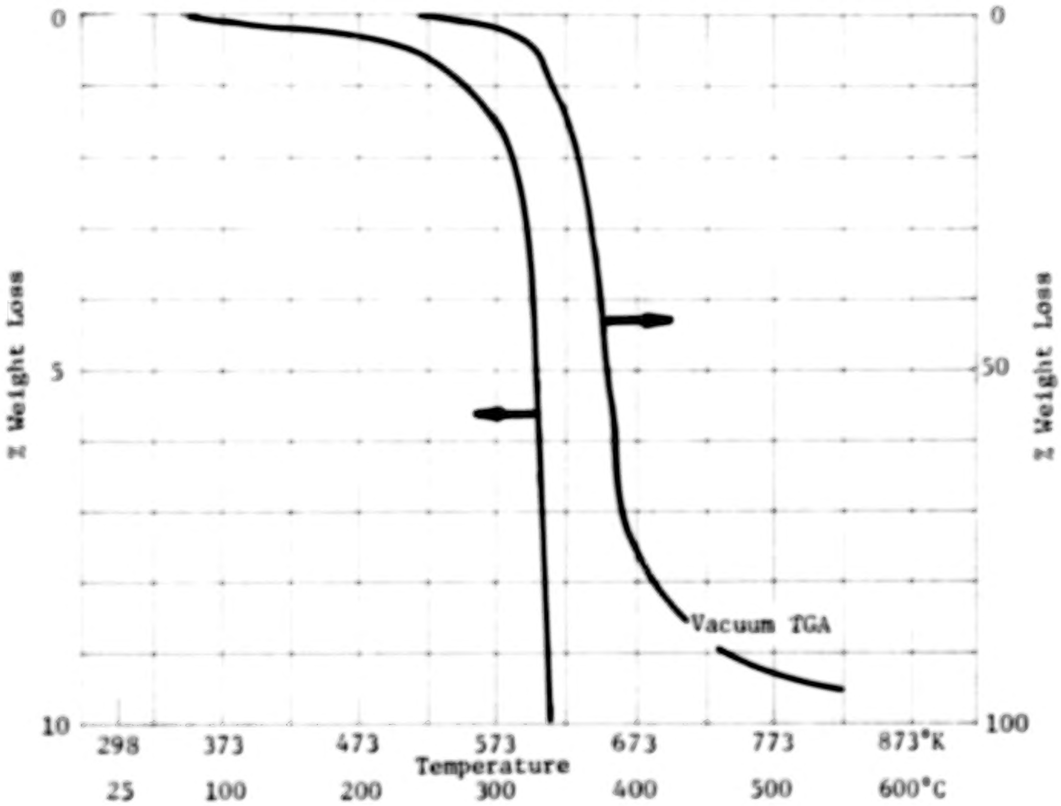
Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 30 pbw Catalyst**
Cure: **2 hrs. at 333°K (60°C), 8 hrs. at 394°K (121°C),**
4 hrs. at 453°K (180°C)

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **473°K (200°C) - 773°K (500°C)**

a_o **=92.5%** of initial weight

$$k = 5.0\times10^{7} \ \exp\left(\frac{-26,000}{1.98\ T^{\circ}K}\right) \ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**5.6×10^{9}**	
373°K (100°C)	**2.4×10^{7}**	
423°K (150°C)	**3.7×10^{5}**	

Number and Relative Peak Intensity

Temperature, °K (°C) Brazil 89/Hz

m/e	298 (25)	573 (300)	623(350)	673 (400)	823 (550)		
14	1737	2003	13584	2044	4212		
15	961	2636	44637	5580	8185		
16	5527	7316	22356	4196	14588		
17	25426	26368	80472	10562	21047		
18	86917	92165	100964	35889	66417		
19	121	199	5018	1309	243		
20	477	456	1464	203	636		
21			42				
22			79				
23							
24		104	2398	333	230		
25	71	546	9802	1700	957		
26	784	3067	46029	8795	5950		
27	1286	4437	68432	14217	7898		
28	27690	33087	100966	26650	14768		
29	1467	4373	84241	11757	5669		
30	1286	2674	32586	4820	3561		
31	478	1471	32945	7413	1822		
32	6056	5735	8205	2525	5860		
33			1493	416			
34			53				
35		47	347		52		
36		67	1595	197	77		
37		418	10931	2106	511		
38	85	831	21017	4500	1094		
39	345	2917	65526	16296	4081		
40	5994	7561	36936	7752	9197		
41	462	2146	42746	6213	2920		
42	421	2674	66167	5142	2923		
43	966	2827	50653	7606	2931		
44	1280	8575	66125	6326	3400		
45	390	2106	73748	13199	2463		
46		47	2818	493	93		
47		62	3959	653	62		
48			764	49			
49		246	4603	784	160		
50		1613	18049	4661	1080		
51		950	18101	6339	1513		
52		1091	12963	2561	597		
53		367	11815	3591	674		
54		257	7988	1009	305		
55	53	354	14767	3081	956		
56	42	462	17965	1177	687		
57	84	431	10533	1012	669		
58	216	687	21730	1788	1038		
59	289	498	8992	1316	606		
60		69	3016	394	66		
61		59	3465	809	141		
62		63	5701	1721	272		
63		236	10880	3750	689		
64		103	4156	1225	179		
65		559	23851	6551	1178		
66		725	20605	6039	930		
67		190	6232	990	146		
68		214	7383	534	112		
69		115	3217	153	82		
70		50	3811	220	87		
71		60	2976	125	69		
72		41	2445	207	58		
73			3160	520	90		
74		41	2851	858	128		
75		83	8102	1564	177		
76		108	4980	955	116		
77		127	7289	5365	913		
78		297	4164	1609	404		
79		533	7501	3500	542		
80		66	4750	1115	151		
81		42	2138	329	77		
82		48	2565	109	68		
83			1326				
84			1973	59			
85			1029	40			
86			910	83			
87			796	126			
88			435	58			
89			1046	964	137		
90		56	1211	785	101		
91		78	5335	3549	1190		
92		274	2965	503	190		
93		354	5059	760	103		
94		447	36803	7033	951		
95		56	4021	608	78		
96			796				
97			495				
98			346				
99			298				
100			135				
101			265				
102			266	90	92		
103			1082	623			
104			541	121			
105			1289	493	205		
106		99	2529	165	104		
107		130	3688	3319	647		
108		43	3724	1013	236		
109			1150	147			
110			217				
111			145				
112			68				
113			74				
114			49				
115			457	282	45		
116			121				
117			456	130			
118			830	147			
119			3513	1370	135		
120			1127	288	52		
121			2492	1988	173		
122			1065	660	64		
123			361				
124			53				
125			58				
126							
127			41				

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	573 (300)	623 (350)	673 (400)	823 (550)		
128			51				
129			71				
130			152				
131			309	163			
132			412	59			
133			1203	412			
134			4043	1676	132		
135			672	607	41		
136			625	387			
137			98				
138							
139							
140							
141							
142							
143							
144			108				
145			94	55			
146			91				
147			65				
148			173	69			
149			69	40			
150			60				
151			42				
152							
153							
154							
155							
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157							
158			26				
159			69				
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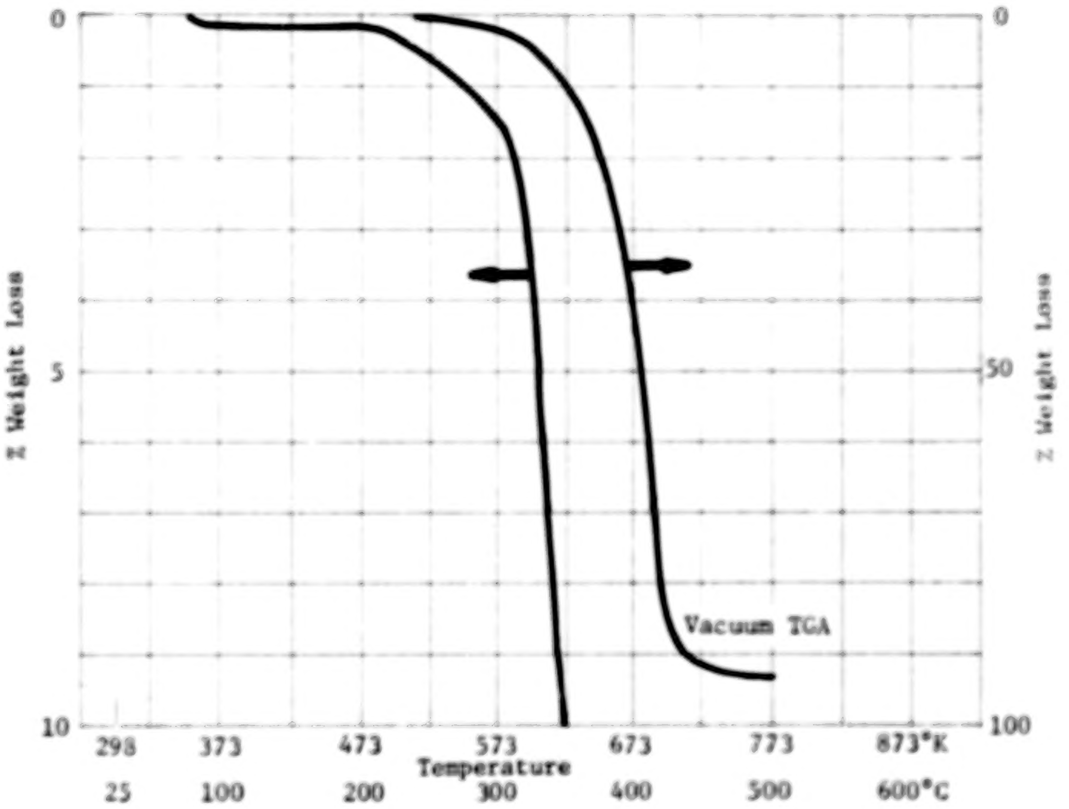
Impregnant 3-BA-4

Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 5 pbw Activator**
Cure: **2 hrs. at 369°K (96°C), 6 hrs. at 408°K (135°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

   Over the Range: **473°K (200°C)-773°K (500°C)**

a_o = **96.5%** of initial weight

$$k = 5.78\text{x}10^7 \exp\left(\frac{-26300}{1.98\ T^\circ K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**7.9 x 10^9**	
373°K (100°C)	**3.2 x 10^7**	
423°K (150°C)	**4.7 x 10^5**	

Number and Relative Peak Intensity

Temperature, °K (°C)   [illegible]

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	2209	2343	2822	12561	2746		
15	593	3943	5758	28869	6507		
16	4372	4120	4664	12721	8298		
17	16578	12594	14784	25730	14229		
18	56712	45302	47695	84695	45265		
19	249	305	304	1133	323		
20	341	316	360	764	420		
21							
22							
23							
24			56	1240	210		
25		67	346	4951	957		
26	329	632	1810	21189	6667		
27	501	740	2257	26120	5021		
28	23325	23434	26913	72946	32761		
29	312	552	3326	41853	3884		
30	295	888	2617	9023	1259		
31	50	81	550	14193	965		
32	5606	5097	5006	6413	9125		
33				349			
34							
35		109					
36				1268	104		
37			125	7926	672		
38			272	13365	1234		
39	66	137	923	61734	4557		
40	2628	3132	3655	19803	4741		
41	58	235	1157	15945	1890		
42	41	1061	3984	16799	1383		
43	66	354	2177	52263	3526		
44	920	1157	2488	16035	2091		
45		41	376	5394	520		
46				559	61		
47		117		2009	68		
48				311			
49		169	83	1970	216		
50		2012	1027	8488	1610		
51		72	204	6763	1860		
52		589	358	3367	669		
53			156	7075	914		
54			64	1931	184		
55			211	9499	912		
56			416	4163	429		
57		88	714	10685	369		
58		1733	4835	6798	311		
59		663	1674	1245	91		
60				1058	74		
61				2192	196		
62				3295	479		
63				6323	1019		
64				2133	306		
65			61	15624	1676		
66			85	20367	1381		
67			58	2588	218		
68			92	1330	89		
69				1095	46		
70			42	562			
71			62	647			
72				1264	100		
73				703	47		
74				2742	291		
75				970	158		
76				763	142		
77			42	5198	1634		
78			41	2115	612		
79				3149	723		
80				1981	169		
81			41	1761	75		
82			40	985	41		
83				300			
84		67	145	675	109		
85				651			
86				509	57		
87				432	54		
88				63			
89				965	231		
90				855	164		
91				3357	1665		
92				677	304		
93				1204	94		
94			80	29075	1620		
95				2626	98		
96				445			
97				196			
98				106			
99				105			
100				92			
101				100			
102				190	40		
103				791	247		
104				161	63		
105				587	551		
106				254	161		
107				3484	1,40		
108				2270	502		
109				267			
110				107			
111							
112				109			
113							
114				43			
115				424	165		
116				87			
117				181	76		
118				165	66		
119				1172	279		
120				312	92		
121				1960	583		
122				572	171		
123				62			
124							
125							
126							
127				40			

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Impregnant 3-BA-4

m/e		473 (200)	573 (300)	673 (400)	773 (500)		
128				125			
129		60	53	210	72		
130							
131				459	168		
132				762	121		
133				320			
134				906	149		
135				147			
136				262			
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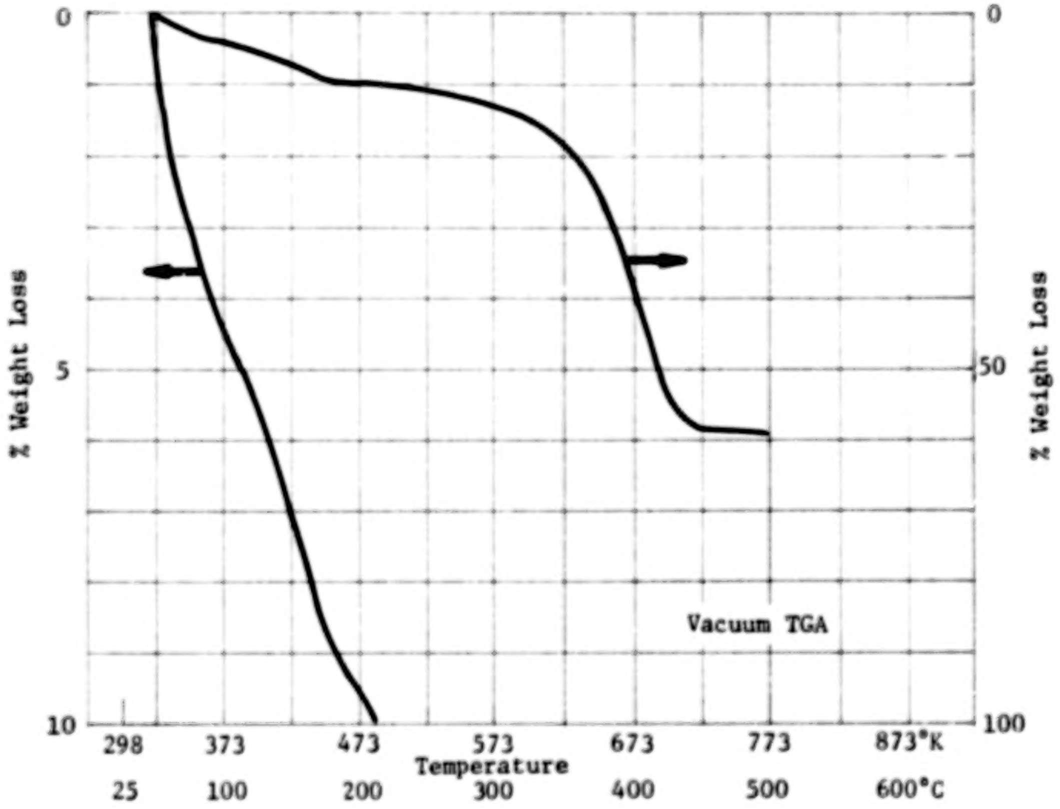
Ink, Cat-L-Ink 50-100/
Cat. 20

Chemical Characterization Summary

Mix Ratio: 100 pbw 50-100 to 6 pbw of Catalyst 20
Cure: 1 hr. at 366°K (93°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 523°K (250°C)-723°K (450°C)

a_o = 47.8% of initial weight

$$k = 5.4\text{x}10^{8} \exp\left(\frac{-28800}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	4.0×10^{10}	
373°K (100°C)	9.5×10^{7}	
423°K (150°C)	9.5×10^{5}	

Number and Relative Peak Intensity

Temperature, °K (°C) Ink, Cat-L-Ink 50-100, White

m/e	298 (25)	473 (200)	623 (350)	673 (400)	673 (500)		
14	1450	1815	3423	4215	1887		
15	418	2291	9777	8750	2436		
16	2610	2383	4811	6114	3821		
17	10333	8045	13606	13312	6445		
18	37367	26105	47135	46529	22167		
19	85	356	124	292	43		
20	229	274	339	403	238		
21							
22							
23							
24		45	194				
25		210			240		
26	231		8237	13953	2064		
27							
28	22357	24217	37598	43590	21943		
29	421	6985	8612	16509	1672		
30	65		6456	5368	402		
31		4392					
32	5429	4731	4859	5263	4136		
33							
34							
35							
36			72				
37					148		
38		75					
39			8458	27785	1964		
40	1211				1480		
41		2675		10514	810		
42			12682				
43		3242		12835	828		
44	244		11006		868		
45		10138	4288		157		
46		103	175				
47			315	2035			
48							
49							
50		215	2418	7331			
51		85	1988	7470	722		
52		49	1376		152		
53		43	1616	4677	200		
54		101					
55		209	3815	11484	229		
56					94		
57		3751		5807	119		
58			8220		68		
59		3929	2099	417			
60		70	80				
61			189		45		
62							
63		46	1058	5856	282		
64							
65		42			674		
66			4449	20057			
67			894				
68			447	786			
69		63					
70		42	1818	3416			
71			604	292			
72		2699	429				
73		2320	227				
74		47	191	1515	44		
75		43	64	754			
76							
77			739	5691	638		
78					142		
79			581	2681	175		
80			580	491	40		
81			253	162			
82			194	109			
83			342	734			
84			371	283			
85		923	158	61			
86				69			
87		65	43	61			
88							
89		51		838	91		
90			76		60		
91		114	460	6675	721		
92			73	661	57		
93					44		
94			8192	31317	736		
95			668	2063			
96				46			
97							
98			54	83			
99							
100							
101							
102				174			
103		62		1336	64		
104				153			
105				745	104		
106				65	59		
107			680	4803	499		
108			732	1859	143		
109				48			
110			45	64			
111							
112			57	194			
113							
114							
115				40	40		
116				544			
117				78			
118				179			
119			148	2211			
120			43		106		
121							
122			155	5419	228		
123			101	1055	50		
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Ink, Cat-L-Ink 50-100, White

m/e	298 (25)	473 (200)	623 (350)	673 (400)	673 (500)		
128							
129				84	43		
130				132			
131			58	50	82		
132			57	830	68		
133				466			
134				696			
135			223	2153	78		
136				314			
137			47	1090			
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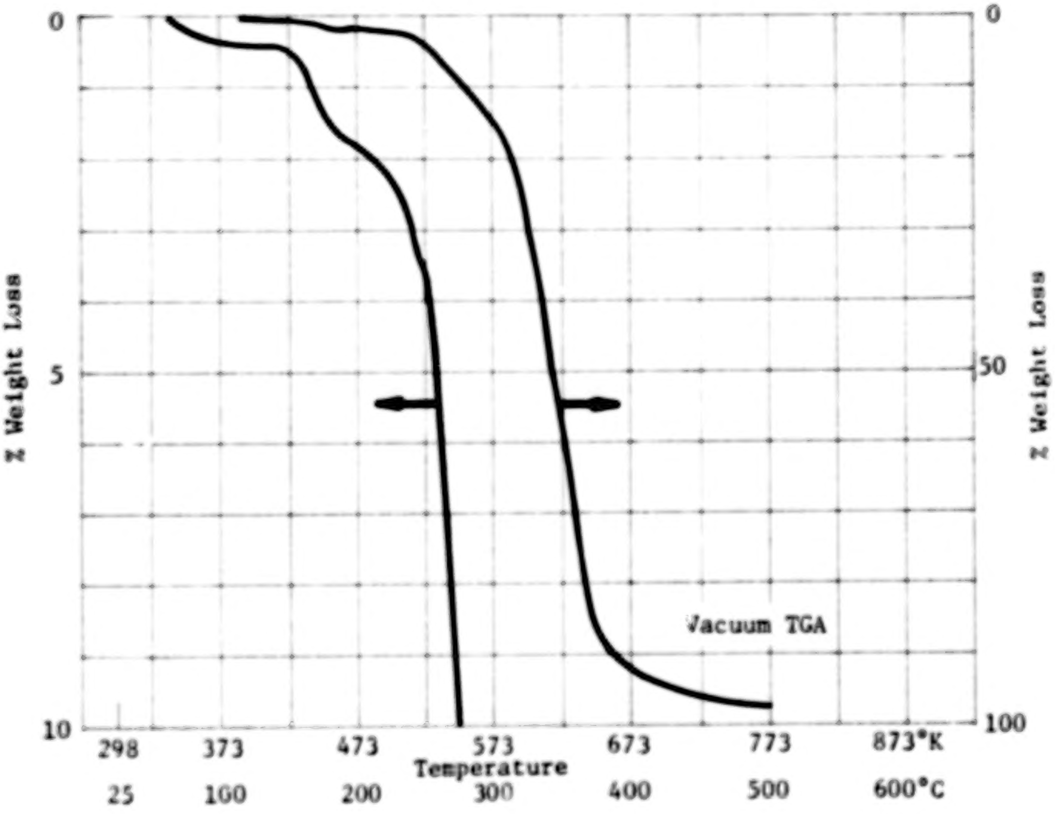
Chemical Characterization Summary

Mix Ratio: 100 pbw resin to 6.4 pbw activator
Cure: 1 hr. at 422°K (149°C)

1. TGA Preconditioning: None



2. Activation Energy of Decomposition:

Over the Range: 473°K (200°C) - 673°K (400°C)

a_o = 92.3% of initial weight

$$k = 1.69 \times 10^{22} \exp\left(\frac{-62,000}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	4.2×10^{19}	
373°K (100°C)	9.6×10^{13}	
423°K (150°C)	4.7×10^{9}	

Number and Relative Peak Intensity

Temperature, °K (°C) Ink, Cat-L-Ink 50-300-9

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
14	1680	1609	1959	4418	2100		
15	646	528	1854	8899	2303		
16	2722	2487	4246	5716	3665		
17	12280	9299	13450	14019	8056		
18	44047	34068	43699	48693	27844		
19	49	59	158	335	58		
20	249	197	316	361	259		
21							
22							
23							
24							
25							
26	144	197	2291	12370	2605		
27							
28	24382	22810	27071	43471	25121		
29	976	832	2142	12809	2204		
30	124	115	1370	2705	492		
31							
32	6685	6416	5863	6020	5836		
33					408		
34					1280		
35					69		
36					566		
37			68				
38			229				
39				23869	2720		
40	1713	1596	2400	11835	2436		
41		49		4449	822		
42			1106				
43		65		11990	1105		
44	309	671	2111	4060	910		
45			189	1212	87		
46				294			
47				.022			
48							
49					54		
50			217	6646			
51			182	6252	1019		
52			176		240		
53			160	3349	336		
54			106		53		
55			80	5951	424		
56			115	1757	118		
57			50	1146	150		
58				1226	58		
59			42				
60			46				
61					45		
62					178		
63				5016	554		
64			46				
65			63		1312		
66			101	18308	1144		
67			351	1514	62		
68				617			
69				129			
70				59			
71							
72				80			
73							
74				1295	71		
75				644			
76					85		
77				3835	881		
78					164		
79				1687	286		
80			43	276			
81				80			
82				48			
83							
84				45			
85							
86				49			
87				44			
88							
89				518	58		
90			469				
91				3602	930		
92				421	75		
93					96		
94				28064	1748		
95				1797			
96				44			
97							
98							
99							
100							
101							
102				59			
103				614	80		
104				71			
105				590	171		
106							
107				2688	570		
108			55	819	159		
109							
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112					47		
113							
114					48		
115				275	49		
116					41		
117				76			
118							
119				2504			
120					260		
121				548	81		
122				2804	322		
123					52		
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Ink, Cat-L-Ink 50-300-9

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
128				42			
129	45		43	93	54		
130				40	43		
131		40					
132	43	60		452			
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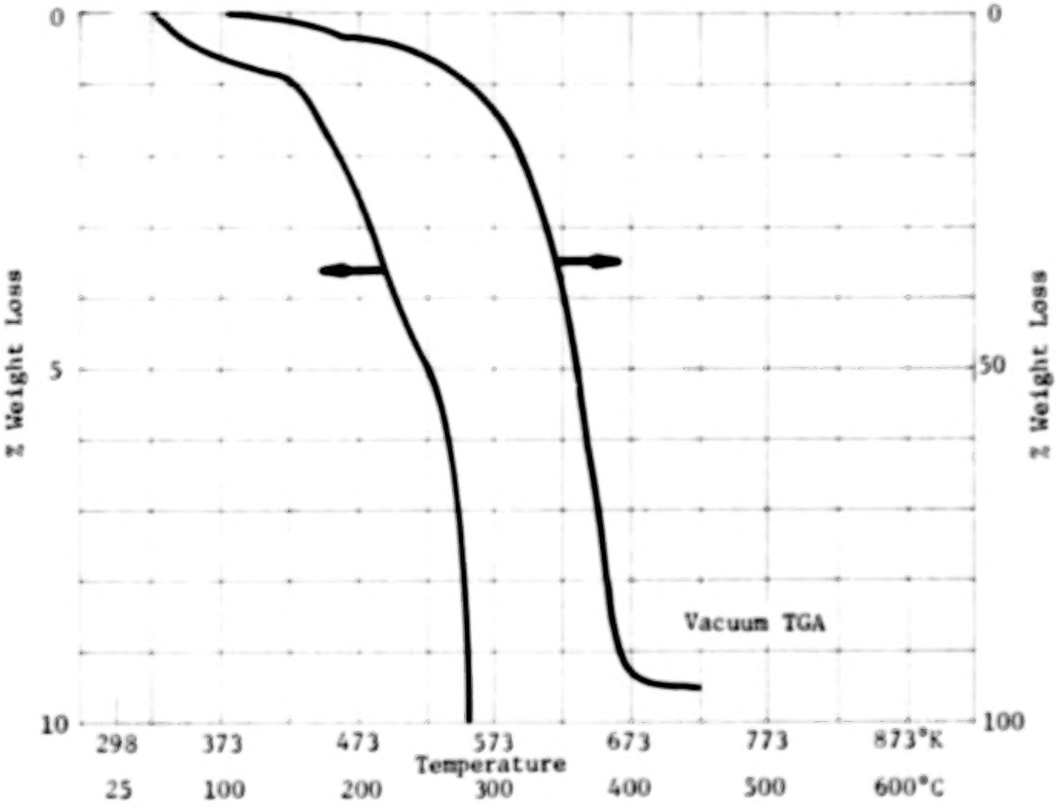
Chemical Characterization Summary

Mix Ratio: **As Received**
Cure: **1 hr. at 422°K (149°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-833°K (560°C)**

a_o = **92.1%** of initial weight

$$k = 2.7\times10^{12} \exp\left(\frac{-37400}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	5.5×10^{12}	
373°K (100°C)	2.1×10^{9}	
423°K (150°C)	5.5×10^{6}	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	523 (250)	623 (350)	673 (400)		
14	1585	1623	1978	4860	2661		
15	196	456	1599	9368	3296		
16	2719	3132	6539	6962	3729		
17	12036	10951	14119	26059	9272		
18	44736	37913	45772	95066	32372		
19	110	125	153	333	112		
20	270	292	376	14510	292		
21							
22							
23							
24					129		
25		51	226				
26	120	990	2802	14100	5257		
27							
28	24090	25686	29536	45720	29120		
29	166	590	1505	13893	3924		
30	66	157	620	3511	795		
31	47	79					
32	5967	5298	5306	5473	4562		
33				68	67		
34							
35							
36			43		152		
37			65				
38							
39				28260	9660		
40	1762	1766	2323	13903	5066		
41		101		6156	2356		
42		120	986				
43		150		12072	6691		
44	325	2092	5361	6254	1963		
45		62	290	1939	303		
46					68		
47				2237	367		
48				215			
49							
50		40	236	7364			
51			107	7665	3360		
52			105				
53			146	4424	1587		
54			90		215		
55			83	6779	1961		
56			212	1989	323		
57			67	2185	312		
58			41	1497	390		
59			43		70		
60			49		165		
61							
62							
63				5861	2276		
64			43	21307			
65			195		1222		
66			186		5260		
67			248		416		
68				916			
69				284	127		
70				152	61		
71				80			
72				130			
73					77		
74				1696	419		
75				836	226		
76					200		
77			47	4878	3093		
78					783		
79			46	2805	1112		
80			63	714	93		
81				265	63		
82				129			
83				66			
84				173			
85				250			
86				75			
87							
88							
89				794	376		
90							
91				4432	2004		
92				566	251		
93			41				
94			482	33604	7452		
95				2167	350		
96				93			
97							
98							
99							
100							
101							
102				79	67		
103				752	560		
104				96	63		
105				790	552		
106					160		
107				6152	2050		
108				1656	551		
109				89			
110				50			
111							
112							
113							
114							
115							
116				694	265		
117				69	155		
118				143			
119				285	120		
120				2813	1383		
121				609	132		
122				2631	2578		
123				620	280		
124							
125							
126							
127	57						

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	523 (250)	623 (350)	673 (400)		
128				49			
129		57	66	109	61		
130					100		
131	41	45	63	576			
132	61	68	110	279	307		
133							
134				736	210		
135				2973	1109		
136				251	109		
137				521	341		
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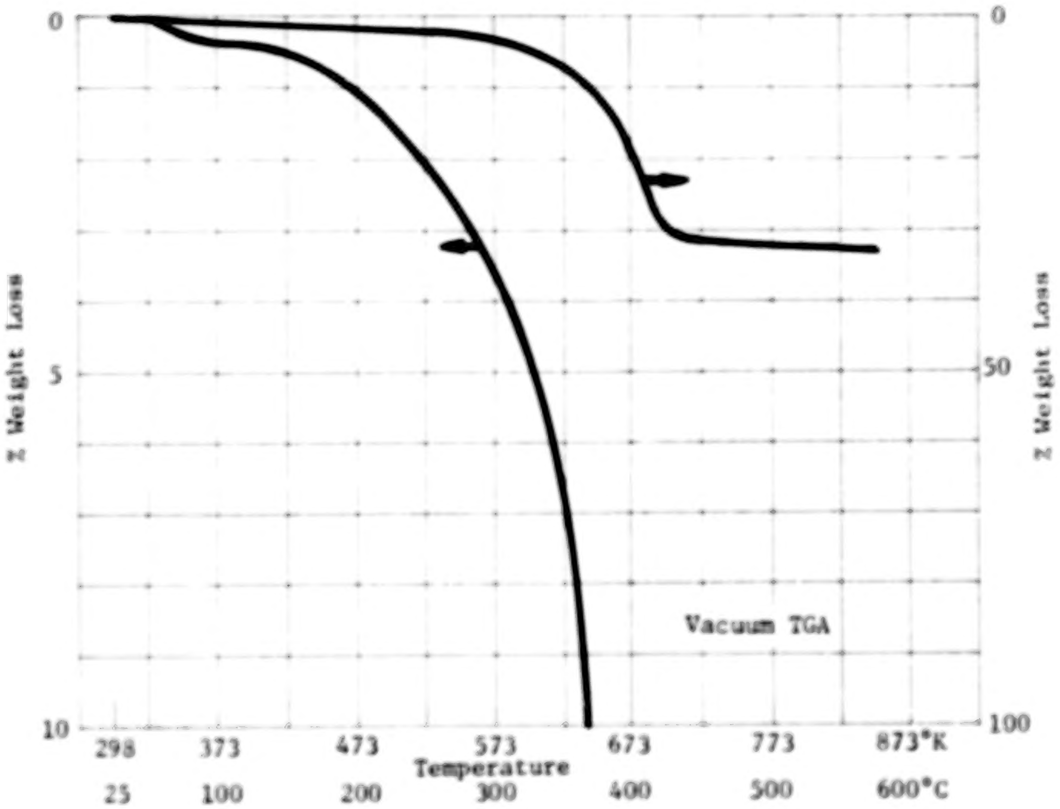
Chemical Characterization Summary

Mix Ratio: 100 pbw of Resin to 5 pbw of Catalyst
Cure: 1½ hrs. at 422°K (149°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 298°K (25°C)-583°K (315°C)

a_o = 33% of initial weight

$$k = 4.6 \quad \exp\left(\frac{-6510}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	3.5×10^3	
373°K (100°C)	8.8×10^2	
423°K (150°C)	3.1×10^2	

Number and Relative Peak Intensity

Temperature, °K (°C)   Ion, [illegible]

m/e	298 (25)	423 (150)	623 (350)	673 (400)	773 (500)		
14	2303	2459	4675	5155	2961		
15	638	1360	9896	7636	2994		
16	4683	4873	7000	7702	5691		
17	18080	15920	18980	19682	12519		
18	60310	51563	62992	64096	39911		
19	1385	1622	1567	1261	820		
20	450	397	539	596	432		
21							
22							
23	97	97					
24			365	677	62		
25	66	96	1538	2505	451		
26	539	625	7992	11252	2457		
27	636	1138	10336	10769	2836		
28	28303	28666	45202	45053	29651		
29	695	860	6728	9376	1063		
30	636	726	5614	2155	760		
31	967	1067	2443	2657	1635		
32	6915	6352	5794	6086	5382		
33				176			
34							
35							
36			150	440			
37			953	3501	283		
38			1996	6638	594		
39	103	160	5261	19093	2325		
40	3113	3262	6662	11153	3620		
41	66	175	3916	3238	934		
42	60	592	11305	3613	961		
43	135	469	6577	10294	1120		
44	1131	1928	10629	4106	1301		
45	223	598	4143	1651	695		
46	73	88	265	657	161		
47			176	1355			
48				155			
49			315	1237	90		
50		73	1553	5249	760		
51			1395	5369	620		
52			919	1687	317		
53			991	3088	333		
54			660	606	53		
55			1760	4900	305		
56			2770	1305	162		
57			1454	587	85		
58		598	7640	1956	193		
59		185	1879	176			
60			193	461			
61			169	1333	55		
62			201	2249	178		
63			645	4360	450		
64			275	1419	123		
65			1916	11082	611		
66			2560	13876	766		
67			572	1313	83		
68			611	694			
69			157	97			
70			443	73			
71			491				
72			198	71			
73			271	322			
74			133	1131	81		
75			55	571			
76			41	452	61		
77			452	3914	720		
78			232	1270	650		
79			366	1988	296		
80			652	370	53		
81			237	102			
82			222	64			
83			92				
84	51	69	329	136	72		
85			162				
86			55	62			
87			65	89			
88							
89				575	57		
90				699	42		
91			223	2670	868		
92			76	450	197		
93			191	859			
94			4507	20513	991		
95			610	1340			
96				52			
97							
98							
99							
100							
101							
102				76			
103				615	58		
104				68			
105				620	156		
106				47	41		
107			359	2676	379		
108			363	1194	167		
109							
110							
111							
112							
113							
114							
115				206	63		
116							
117				62			
118				77			
119				1150	60		
120				232			
121			77	2199	142		
122			56	535			
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	423 (150)	623 (350)	673 (400)	773 (500)		
128							
129	89	84	62	136	62		
130							
131		43	85	319	93		
132	60	69	111	217	98		
133				233			
134			50	976	67		
135				111			
136				663			
137							
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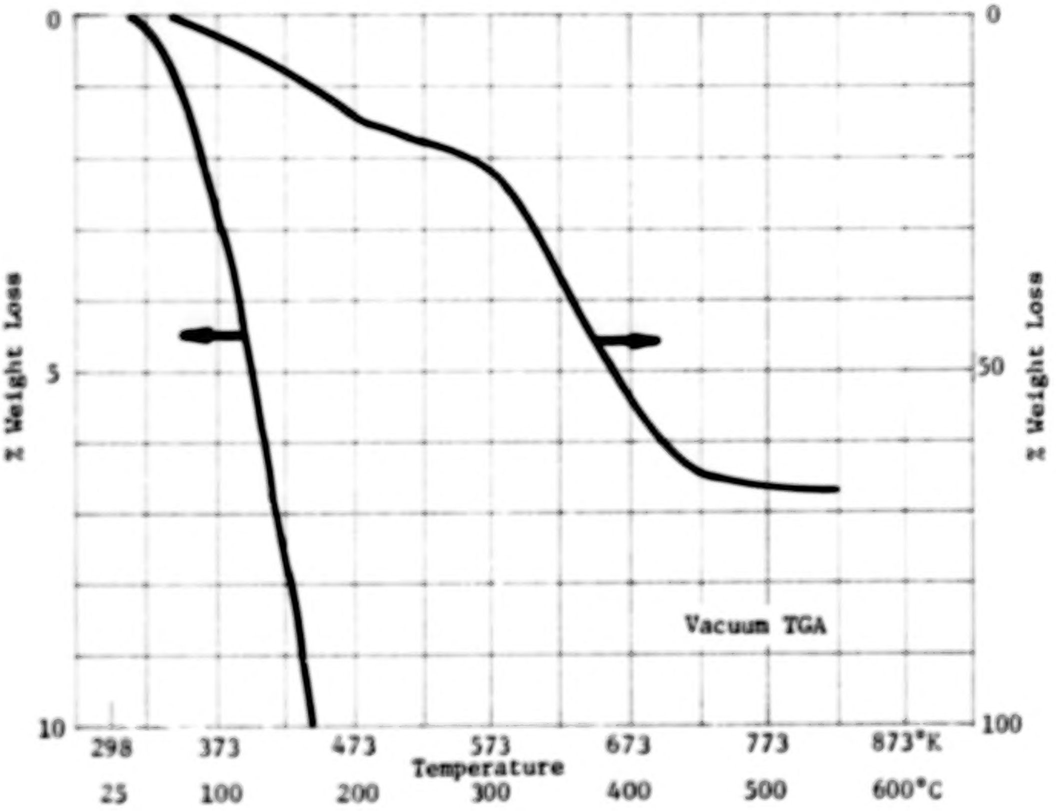
Chemical Characterization Summary

Mix Ratio: Not Applicable
Cure: 15 min. at 422°K (149°C)

1. TGA Preconditioning: None



2. Activation Energy of Decomposition:

Over the Range: 548°K (275°C) - 723°K (450°C)

a_o = 49.2% of initial weight

$$k = 1.23 \times 10^{28} \exp\left(\frac{-80,100}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.2×10^{26}	
373°K (100°C)	6.0×10^{18}	
423°K (150°C)	1.6×10^{13}	

Number and Relative Peak Intensity

Temperature, °K (°C) Ink, Markem 7224

m/e	298 (25)	473 (200)	573 (300)	673 (400)	873 (550)		
14	898	2221	1704	2647	2024		
15	47	3116	2110	4862	3948		
16	1355	2877	2951	6389	6550		
17	5531	5969	6658	12068	6598		
18	20015	21128	22524	35872	20070		
19		406	43	65			
20		46	55	82	40		
21							
22							
23							
24		272	54				
25							
26		9715		11643	3405		
27	45						
28	16156	36107	31047	34916	24559		
29		13062	8694	8881	2886		
30					369		
31		15690	3653	4028			
32	3837	4347		77	3387		
33		931					
34							
35							
36							
37							
38							
39		8826	5347	23537	3638		
40	407						
41		20047	11315	9071	3394		
42							
43		10670		8086			
44	63		7891		2766		
45		1264	323	535	43		
46				297			
47				1267			
48			52				
49			84				
50		1265	1293	8597	1231		
51		845	770		1313		
52					488		
53				4355	450		
54							
55				5615	682		
56		15366	4280	2038	610		
57			2946	2055	467		
58		59	108				
59							
60							
61							
62							
63				5368	433		
64		42					
65		72	56	14579	788		
66		50			557		
67		3076	1973		146		
68		54					
69		47		84			
70				43			
71				46			
72		59		45			
73		109		105			
74				1495	60		
75					56		
76			468				
77		79	112	7706	1091		
78					286		
79			48	3358	327		
80				682			
81				383			
82		2651	1939	829	70		
83		76	77	67			
84		41		47			
85							
86							
87							
88							
89				1023	41		
90							
91		62		5282	1185		
92					114		
93							
94				21448	755		
95							
96							
97							
98		184	429	191			
99		6440	10997	5650	2188		
100							
101				46			
102							
103		51	1252	4948	771		
104							
105				947	290		
106					67		
107				6624	912		
108				2877	307		
109				60			
110							
111							
112							
113							
114							
115				623	43		
116				44			
117				220			
118				348			
119				1945	56		
120				854			
121				7400	261		
122				1487	50		
123							
124							
125		105	249	89			
126				74			
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Ink, Marker 7224

m/e	298 (25)	473 (200)	573 (300)	673 (400)	823 (550)		
128				54			
129				48			
130							
131					66		
132					42		
133							
134							
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153							
154							
155							
156				1984			
157				626			
158				1962			
159		415	805	238	58		
160				401			
161				151			
162							
163			430				
164		144					
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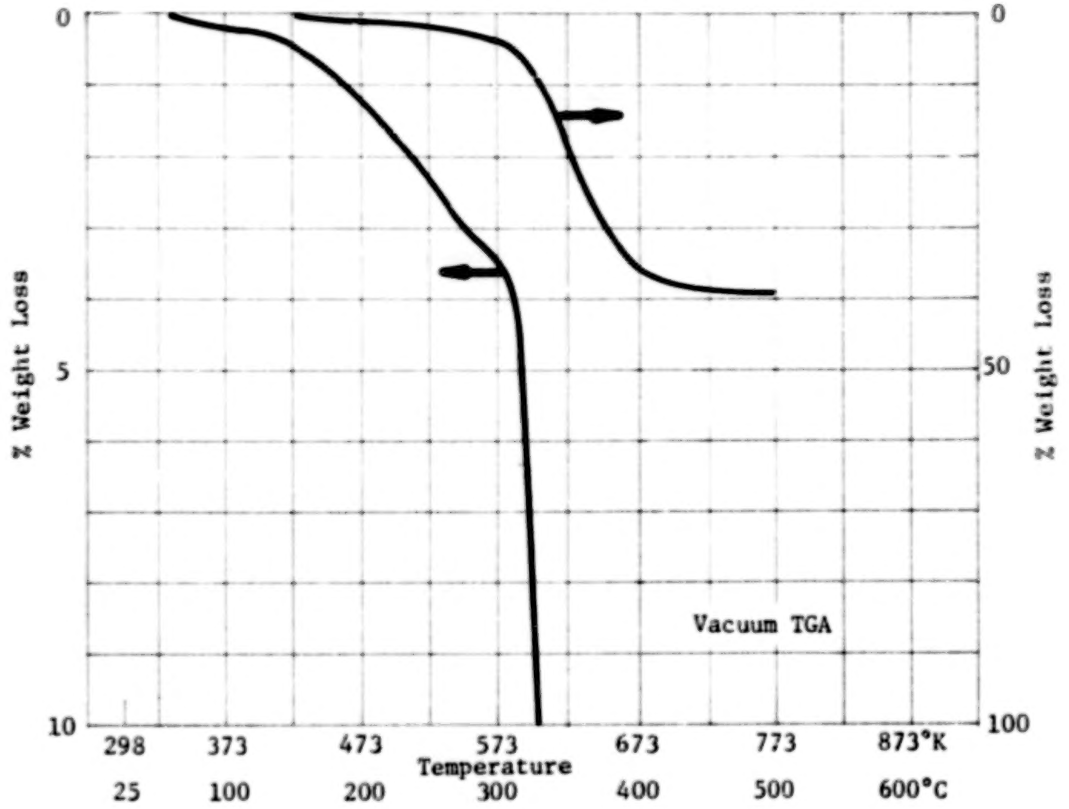
Chemical Characterization Summary

Mix Ratio: **1 pbw resin to 1 pbw activator**
Cure: **6 hrs. at 333°K (60°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **573°K (300°C)- 773°K (500°C)**

a_o **= 37.7% of initial weight**

$$k = 1.3\times10^{11} \exp\left(\frac{-34{,}100}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	7.1×10^{11}	
373°K (100°C)	5.5×10^{8}	
423°K (150°C)	2.3×10^{6}	

Number and Relative Peak Intensity

Temperature, °K (°C) Ink, M-O-N, Black

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
14	1079	1186	1418	5060	1674		
15	144	694	1126	10658	1521		
16	1976	1898	2335	5081	2980		
17	8622	7429	8440	13754	6723		
18	30965	26393	30104	48343	22975		
19				118			
20	41			86	41		
21							
22							
23							
24							
25			59				
26	79	287	730	12215	1649		
27							
28	17790	17904	19408	37284	19782		
29	226	447	1055	9947	1244		
30		107	239		201		
31							
32	4411	4060	3869	4869	3761		
33				261			
34							
35							
36							
37							
38							
39				27606	2427		
40	658	620	615		1460		
41		56			688		
42							
43				24772			
44	232	734	2520		1606		
45		52	452		119		
46							
47				2184			
48							
49		49					
50		137	48	7021	830		
51							
52					223		
53				3790	249		
54							
55				6081	248		
56					51		
57			75		47		
58		54	105	4033			
59			68				
60			61	2110			
61					40		
62					134		
63				5686	426		
64					75		
65							
66				22026	1143		
67					42		
68				754			
69				107			
70				61			
71							
72							
73							
74				1567	53		
75				653	40		
76							
77				3898	749		
78					355		
79				1895	222		
80				231			
81				100			
82				42			
83				53			
84							
85				45			
86				47			
87				62			
88				41			
89				547	45		
90					51		
91				3921	677		
92					59		
93							
94				37070	1510		
95				2373			
96				100			
97				40			
98							
99							
100							
101							
102							
103				793	64		
104				43			
105				708	177		
106				164			
107				2099	515		
108				721	141		
109							
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113							
114							
115					57		
116				457	50		
117				49			
118				111			
119							
120				3201	192		
121				621			
122				3532	260		
123				320			
124							
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Ink, M-O-N, Black

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
128							
129				62			
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155							
156							
157							
158				1013	46		
159				267			
160				1064	40		
161				1082			
162				262			
163							
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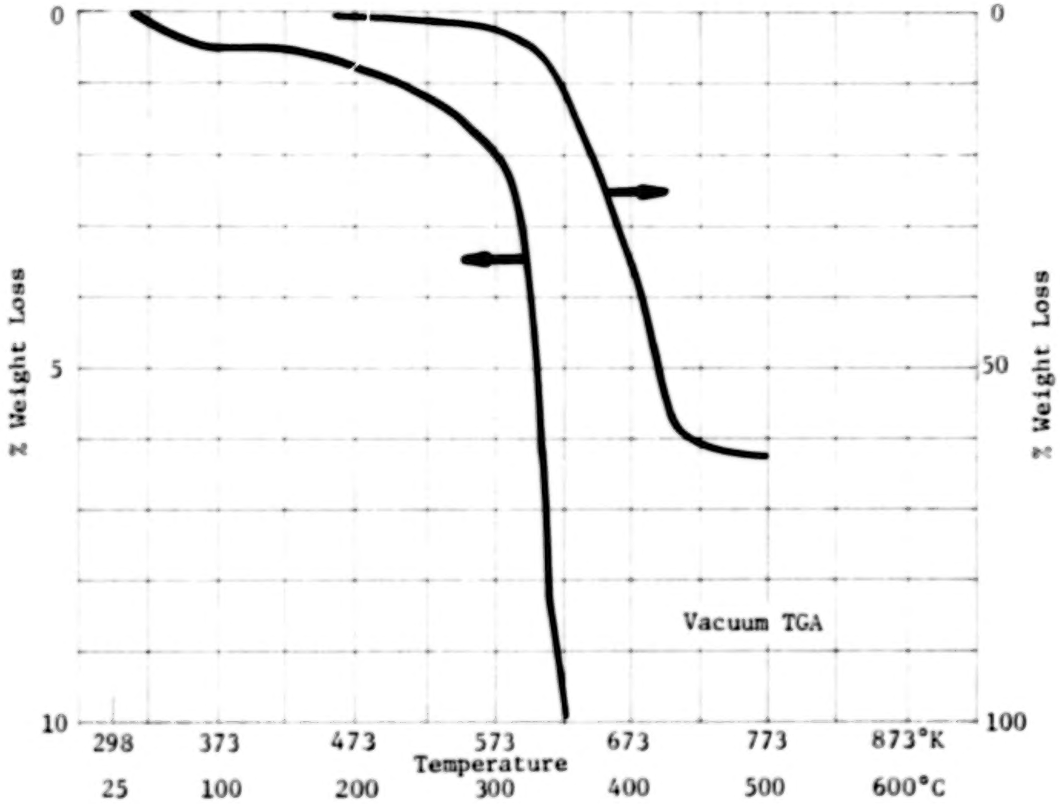
240							

Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 6 pbw Catalyst**
Cure: **1 hr. at 422°K (149°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C)-723°K (450°C)**

a_o = **61.1%** of initial weight

$$k = 2.48\times10^{10} \exp\left(\frac{-33200}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C) 373°K (100°C) 423°K (150°C)	8.7×10^{11} 8.2×10^{8} 4.0×10^{6}	

Number and Relative Peak Intensity

Temperature, °K (°C) Ink, Red, 50-507-9

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	773 (500)	
14	2252	2353	2258	5603	3022	3177	
15	848	1301	1191	11994	3251	3529	
16	4991	4961	4916	10104	6124	7055	
17	18220	16080	15713	27849	15676	15142	
18	60517	52218	50565	90383	49301	48284	
19	1163	1246	1195	1416	951	910	
20	852	890	905	1416	1137	1316	
21							
22							
23							
24				777	179	155	
25	56	213	143	2689	775	697	
26	457	1235	916	14095	3772	3296	
27	595	1659	1032	18008	4213	3625	
28	26602	27691	26646	53525	33822	32107	
29	361	2041	999	13096	3268	2530	
30	464	612	518	7534	1145	1045	
31		879	277	4809	908	596	
32	6338	5962	5750	5962	5828	5968	
33				84	176	247	
34				41	454	677	
35							
36		53	63	421	199	169	
37				2038	829	493	
38		81	71	3735	1704	953	
39		625	216	11381	5775	3420	
40	3446	3489	3441	9621	5450	4722	
41	76	1112	262	8971	2007	1456	
42	60	407	307	14206	1437	1158	
43	93	1287	473	10060	2693	1805	
44	732	1200	1466	10965	2037	1616	
45		1795	229	3076	479	367	
46		40		564	90	66	
47				541	230	87	
48				202	40		
49				716	297	171	
50		120	114	3086	1653	1049	
51		124	53	2995	2061	1311	
52		43	45	2240	675	450	
53		49		2843	1068	604	
54				2311	286	171	
55		168	85	5958	1449	934	
56		108	96	5646	519	378	
57		1348	77	4528	873	671	
58		404		2974	373	286	
59		609		688	76	53	
60			40	506	168	89	
61				461	309	162	
62				781	613	354	
63				1478	1365	826	
64	44			802	448	293	
65		83	44	3864	2756	1531	
66	64	61	71	5181	2959	1477	
67		57	41	2352	354	199	
68				1194	172	100	
69		106		1066	97	58	
70				3331	195	120	
71				1022	42		
72		491		556	51		
73		440		308	88	54	
74				440	317	172	
75				217	204	115	
76				189	175	86	
77		65		955	1878	1059	
78		58	40	636	650	476	
79				877	791	419	
80				1586	180	104	
81				757	74	67	
82				698	75	65	
83		43		951	96	61	
84	113	169	105	697	182	164	
85		727		307			
86		40		191	53	52	
87				48			
88							
89				174	246	177	
90				130	173	89	
91		129		793	1622	1226	
92				258	232	214	
93				526	241	130	
94				9571	3803	2035	
95				1069	256	123	
96				202			
97				369			
98				187			
99				76			
100				57			
101							
102					56		
103				60	359	218	
104					71	62	
105				40	339	327	
106				154	58	95	
107				801	1166	639	
108				788	393	243	
109				188			
110				51			
111				138			
112				476	140	48	
113				55			
114				57		44	
115				65	168	100	
116							
117					95	88	
118				91	50	47	
119		60		373	574	321	
120				161	188	115	
121				222	977	592	
122				153	123	88	
123							
124							
125							
126				43			
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Ink, Red, 50-507-9

m/e	298 (25)	423 (150)	573 (250)	623 (350)	723 (450)	773 (500)	
128							
129	113	131	123	187	132	142	
130							
131	83	75	82	170	223	173	
132	118	112	108	191	180	184	
133				95	130	40	
134				394	360	236	
135				55	63		
136				49	133	78	
137							
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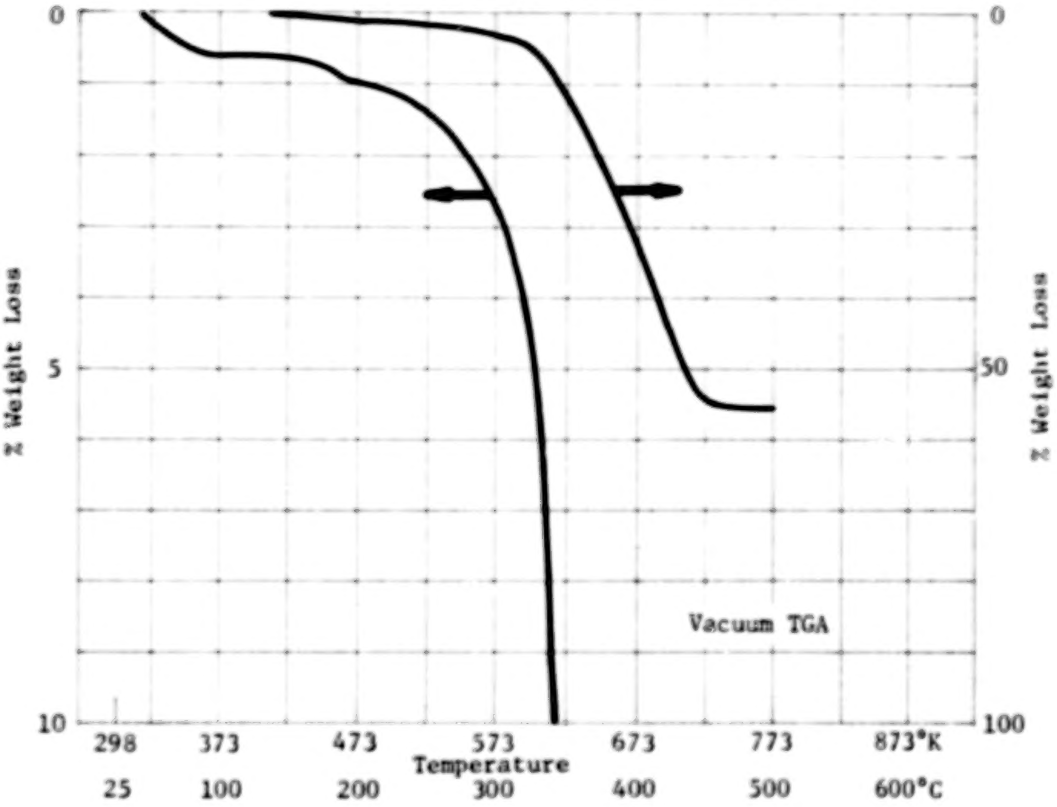
Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 6 pbw Catalyst**
Cure: **1 hr. at 422°K (149°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C)-723°K (450°C)**

a_o = **54.2%** of initial weight

$$k = 2.76 \times 10^{11} \exp\left(\frac{-35500}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**2.7×10^{12}**	
373°K (100°C)	**1.6×10^{9}**	
423°K (150°C)	**5.5×10^{6}**	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible]

m/e	298 (25)	423 (150)	573 (300)	673 (400)	773 (500)		
14	2401	2561	3191	4983	3062		
15	799	1803	3664	6029	2920		
16	5526	5290	6762	9069	6658		
17	21282	17590	21927	19918	15325		
18	72153	57991	71367	146638	40573		
19	1336	1558	1631	3633	3013		
20	1007	932	1329	1606	1316		
21							
22							
23							
24		67	156	727	137		
25	57	384	699	2739	597		
26	448	1965	3731	12348	2950		
27	557	3008	4257	16961	2971		
28	28368	30789	36107	51460	32158		
29	367	4459	[illegible]	15575	2066		
30	422	889	[illegible]	3878	955		
31	96	2444	[illegible]	4517	479		
32	6953	6321	[illegible]	6314	6456		
33					527		
34				69	1356		
35							
36	40	62	155	568	366		
37		61	259	2524	392		
38		125	633	6254	621		
39		1000	1780	20669	2813		
40	3450	3696	4544	11768	4564		
41	69	1978	1520	9578	1099		
42	69	706	2546	5717	1003		
43	77	2762	2485	18717	1459		
44	762	1932	4193	9636	1505		
45		5736	913	1721	289		
46		123	72	578	40		
47			120	1375	91		
48			76	263	68		
49			167	1245	126		
50		216	744	5051	878		
51		186	532	5551	1038		
52		62	161	1972	359		
53		96	469	3762	520		
54			426	1262	120		
55		244	644	10396	736		
56		203	795	3166	309		
57		2712	681	5790	483		
58		893	577	1321	222		
59		2295	286	237			
60		66	219	580	61		
61			62	1269	117		
62			56	2166	296		
63			113	4210	673		
64		40	177	1885	297		
65		73	398	10601	1263		
66	40	60	552	13276	1267		
67		75	512	3613	169		
68			158	766	73		
69		218	109	1115			
70			269	4569	65		
71		78	85	582			
72		1805	76	297			
73		1591	52	427			
74		60		1125	166		
75				631	79		
76				690	62		
77		62	90	1797	876		
78		77	151	1373	370		
79			186	2124	355		
80			325	637	43		
81			137	278			
82			75	288			
83		78	56	1038			
84	113	232	194	603	152		
85		1430	186	145			
86		62	53	142			
87				80			
88							
89		56		671	103		
90				618	53		
91		321	62	2762	1062		
92				873	166		
93			83	788	83		
94			1092	19934	1693		
95			97	1405	86		
96				109			
97				55			
98				170			
99							
100							
101							
102				125			
103		64		629	158		
104				120	86		
105		44		524	258		
106		65		118	61		
107			63	2932	513		
108			134	1605	175		
109				83			
110					47		
111							
112				407	119		
113							
114					103		
115				345	70		
116				62			
117				140	57		
118				188	64		
119				1066	243		
120				340	96		
121				1717	487		
122				431	50		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Ink, Yellow, 50-202-4

m/e	298 (25)	423 (150)	573 (300)	673 (400)	773 (500)		
128							
129	126	122	161	208	144		
130							
131	76	77	101	498	153		
132	126	137	144	305	140		
133				342	40		
134			53	951	207		
135				116			
136				259	61		
137							
138							
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141							
142							
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145				52			
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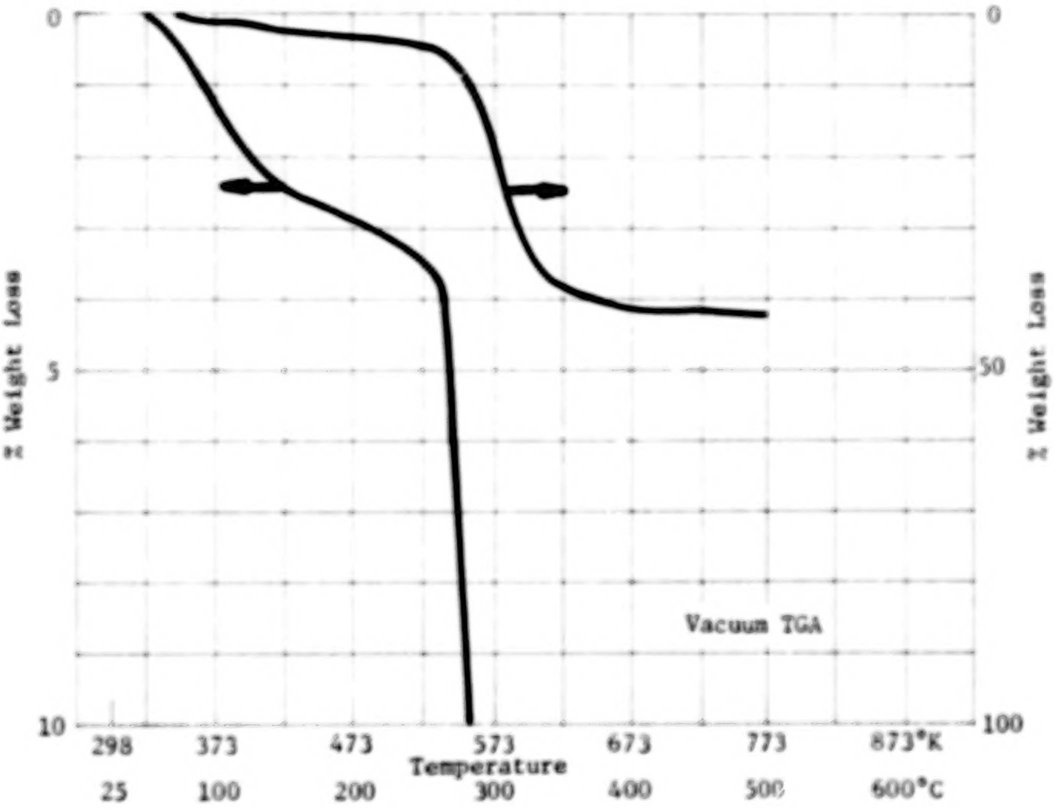
Chemical Characterization Summary

Mix Ratio: **Pre-Preg**
Cure: **30 min. at 447°K (174°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C)-773°K (500°C)**

a_o = **39.8%** of initial weight

$$k = 3.04\times10^{21} \exp\left(\frac{-57000}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	9.4×10^{16}	
373°K (100°C)	6.1×10^{11}	
423°K (150°C)	6.7×10^{7}	

Number and Relative Peak Intensity

Temperature, °K (°C) Laminate, Epoxy / glass [illegible]

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)		
14	1017	661	852	1036	1236		
15	210	214	657	1148	936		
16	2521	2420	3176	3521	2982		
17	12250	9925	11611	11061	8973		
18	46926	36272	36480	36930	33913		
19	120				40		
20	86	41	71	107	87		
21							
22							
23							
24				46			
25				427	170		
26	197	219	457	2993	2625		
27	261	386	777	2944	1964		
28	22966	24732	24276	28751	28199		
29	330	422	661	2165	1423		
30	112	113	235	436	389		
31	368	327	435	1073	999		
32	7257	6805	6329	5876	5725		
33							
34							
35				73			
36				860	140		
37				919	263		
38				2103	575		
39	40	46	131	6066	2383		
40	536	1023	1240	3310	3666		
41	48	61	119	1149	729		
42		59	225	1133	440		
43	112	130	248	1798	731		
44	763	847	2536	4238	1276		
45	102	84	172	534	407		
46				136	103		
47				181			
48				51			
49				190	55		
50			190	1793	529		
51				2033	697		
52			46	482	137		
53				1066	291		
54				87	45		
55				1274	270		
56			58	108	123		
57				87	41		
58		41	71				
59				82			
60				76			
61				255	70		
62				706	102		
63				1567	416		
64				695	68		
65				2705	917		
66				4762	1056		
67				326	55		
68				62			
69							
70							
71							
72							
73							
74				220	50		
75				84	43		
76				86			
77				1441	745		
78				385	167		
79				453	233		
80				77			
81				40	43		
82							
83							
84							
85							
86							
87							
88							
89							
90				65			
91				56			
92				1409	450		
93				298	87		
94				372	54		
95				6504	1532		
96				201			
97							
98							
99							
100							
101							
102							
103							
104				107	91		
105							
106					40		
107							
108				597	309		
109				142	161		
110							
111							
112							
113							
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115							
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119							
120				128			
121							
122				401	81		
123				40			
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Laminate, Epoxy / glass 102-21

m/e				623 (350)			
128							
129							
130							
131							
132							
133							
134							
135				91			
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239							
240							

Table of Contents

Page

1. Tests . . . . vi 1/A9

2. Material Test Index . . . . viii 1/A11

3. Application Index . . . . xii 1/B5

4. Introduction 1 1/B8

5. Discussion of Test Methods

I. Thermochemical Tests 2 1/B9
II. Physical Property Tests 8 1/C1
III. Qualification Criteria for Viking Materials. . . . 10 1/C3

6. Data Section

Material	Manufacturer		
Ablefilm 501-1	Ablestik Labs	15	1/C8
Ablefilm 535-1	Ablestik Labs	18	1/C11
ADX-41	Hysol	20	1/C13
Armstrong A2/ACT E	Armstrong	23	1/D2
Bacon FA13/BA-39	Bacon Industries.	26	1/D6
BC-328A/BC-328C	Dolph	29	1/D9
BLH-EPY 500	Baldwin-Lima-Hamilton . . .	32	1/D12
Bondmaster E645	National Starch and Chemical Corporation.	35	1/E1
C7-4248	Hysol	38	1/E4
CMC-15 Bonding Film	Circuit Material Co. . . .	41	1/E7
Coating G2735 on Electromagnetic Core	Magnetics Corp.	44	1/E10
Coating S8993-8Q_2 on Electromagnetic Core	Magnetics Corp.	46	1/E12
Conductive Epoxy 5504A	E. I. DuPont.	48	1/E14
Conductive Epoxy 8294	E. I. DuPont.	51	1/F3
E-300 Insulating Film	Dyna-Therm Corp..	54	1/F6
EA901/B3	E. V. Roberts	57	1/F9
EA956	Hysol	60	1/F12
EA9320	Hysol	62	1/F14
EA9414	Hysol	65	1/G3
Eccobond 56C/Cat 11	Emerson and Cuming, Inc.. .	68	1/G6
Eccocoat EP-3	Emerson and Cuming, Inc.. .	71	1/G9
Eccoseal 1207/20	Emerson and Cuming, Inc.. .	74	1/G12
Eccostock R-25	Emerson and Cuming, Inc.. .	77	2/A4
ECF-550	Epoxy Coating Co.	80	2/A7

		Page	
EG818T	Mica Corp.	83	2/A10
Epocast 203	Furane Plastics, Inc. . . .	86	2/A13
Epon 815/A	Ceilcote/Eastman.	89	2/B2
Epon 828/Cat 2/Flex 871	Shell Chemical Co.	91	2/B4
Epon 828/MPDA/120 Fiberglass Cloth	Shell Chemical Co.	94	2/B7
Epon 828/Versamid 125	Shell Chemical Co.	97	2/B10
Epon 929/B	Hysol	100	2/B12
Epo-Tek H43	Epoxy Technology, Inc. . .	102	2/C1
Epo-Tek H72	Epoxy Technology, Inc. . .	105	2/C4
Epo-Tek 417	Epoxy Technology, Inc. . .	108	2/C7
Epo-Tek 417	Epoxy Technology, Inc. . .	111	2/C10
Epoxy 450 Tubing	3M Co.	114	2/C13
ES-222	Polyscientific.	117	2/D2
FM-40	American Cyanamic Co. . . .	120	2/D5
FM-96 Supported Film	American Cyanamid Co. . . .	123	2/D8
High Temp 221	High Temp Resins.	127	2/D12
HT435 Film Adhesive	American Cyanamid Co. . . .	130	2/E1
Hysol AS-7-4315	Hysol	133	2/E4
Hysol C9-4183/H2-3561	Hysol	136	2/E7
Hysol R9/H2	Hysol	139	2/E10
Impregnant 3-BA-4	Bacon Industries.	142	2/E13
Ink, Cat-L-Ink 50-100, -Cat. 20	Wornow Process Paint. . . .	145	2/F2
Ink, Cat-L-Ink 50-300-9	Wornow Process Paint. . . .	148	2/F5
Ink, Cat-L-Ink 50-407-9	Wornow Process Paint. . . .	151	2/F8
Ink, M-9-N/Cat A	Wornow Process Paint. . . .	154	2/F11
Ink, Markem 7224	Markem Corp.	157	2/F14
Ink, M-O-N, Black	Wornow Process Paint. . . .	160	2/G3
Ink, Red, 50-507-9	Wornow Process Paint. . . .	163	2/G6
Ink, Yellow, 50-202-9	Wornow Process Paint. . . .	166	2/G9
Laminate, Epoxy/Glass 102-21	Mica Corp.	169	2/G12
Laminate, Mil-P-13949 FL-GFN	Fortin.	172	3/A4
Laminate, E-787	U.S. Polymeric, Inc. . . .	174	3/A6
Laminate, G-10 FR Clad	Norplex	176	3/A8
Laminate, G-10 FR Unclad	Norplex	179	3/A11
Laminate, L-P-509 GR G-11	Formica Corp.	182	3/A14
LCA-4V/BA-5	Bacon Industries.	184	3/B2
Lefkoweld 46LM 52	Leffingwell	187	3/B5
MF500F-124 Microwave Absorber	Emerson and Cuming, Inc. .	190	3/B8
Paint, Cat-A-Lac 473-3-1/x304	Finch Paint	193	3/B11
Paint, Brolite Gloss Black Enamel	Andrew Brown.	195	3/B13

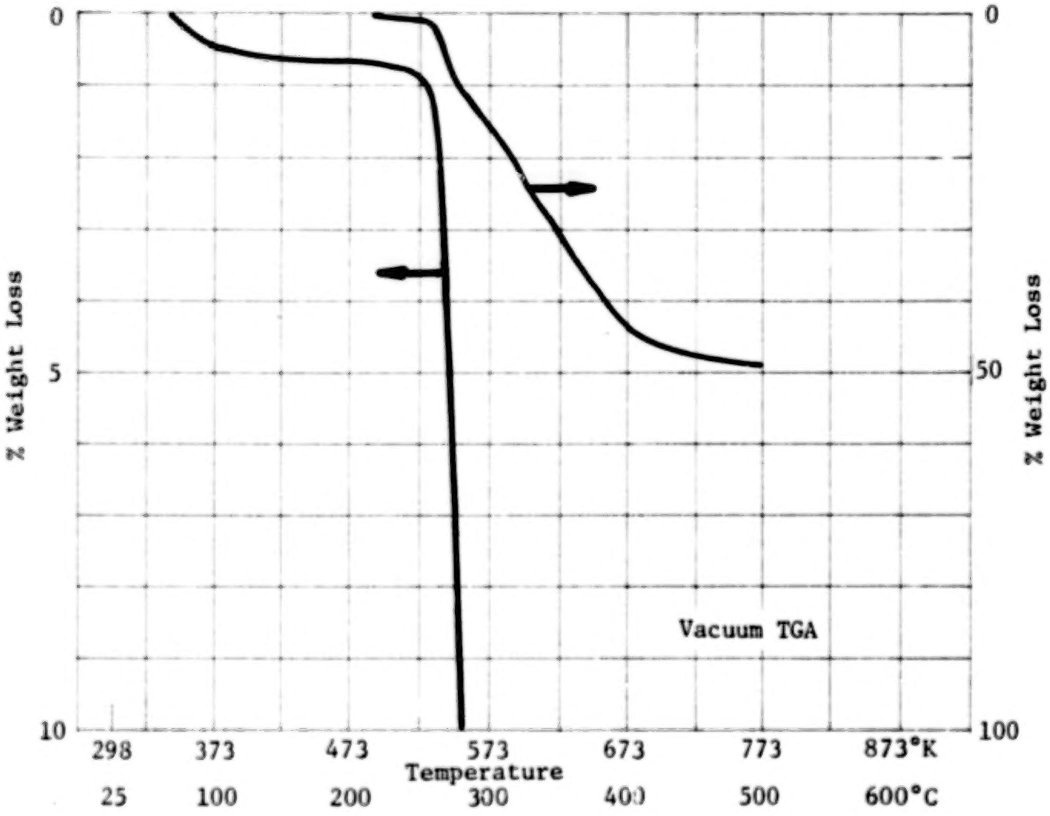
Page

Paint, Brolite Gloss White Enamel Andrew Brown 198 3/C2
Paint, Nextel 401-C10 3M Co. 201 3/C5
Scotchcast 241 3M Co. 204 3/C8
Scotchcast 583 Tape 3M Co. 207 3/C11
Skyspar A423/66 Andrew Brown 209 3/C13
SMRD 100F-90 General Electric 212 3/D2
Stycast 36D Emerson and Cuming, Inc. 215 3/D5
Stycast 1263/Cat. 31 Emerson and Cuming, Inc. 218 3/D8
Stycast 2651/Cat. 9 Emerson and Cuming, Inc. 221 3/D11
Stycast 2651/Cat. 11 Emerson and Cuming, Inc. 224 3/D14
Torr Seal A/B Varian Associates 227 3/E3
Trucast 111M/901 Fenwal, Inc. 230 3/E6
Trucast 111M/902 Fenwal, Inc. 233 3/E9

Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C) - 698°K (425°C)**

a_o **= 26.7%** of initial weight

$$k = 2.4 \times 10^{56} \exp\left(\frac{-147{,}400}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	10^{99}	
373°K (100°C)	1.1×10^{30}	
423°K (150°C)	6.5×10^{19}	

Number and Relative Peak Intensity

Temperature, °K (°C)

[illegible], Mil P-13949 PL-GPN

m/e	298 (25)	523 (250)	573 (300)	673 (400)	773 (500)		
14	1314	1236	1498	1479	1123		
15	316	486	1976	1316	830		
16	2069	2533	4177	2571	2375		
17	10587	8111	8313	7279	6724		
18	39082	23593	31679	23069	24505		
19	123	172	228	130	75		
20	299	224	334	298	275		
21							
22			119				
23							
24			257	152			
25	43	86	905	639	195		
26	320	483	4454	2907	1170		
27	641	759	4270	2954	1457		
28	30594	28219	35791	31412	26811		
29	491	600	3206	2988	991		
30	763	758	1242	1257	863		
31	95	142	635	551	178		
32	5445	5368	5072	4784	4809		
33			129	57			
34							
35			206	50			
36			949	341	141		
37		44	2282	1054	217		
38	48	62	4406	1880	347		
39	102	164	10794	5315	1053		
40	3582	2913	6988	4986	3374		
41	161	147	1294	1161	345		
42	80	192	1851	1003	286		
43	264	369	2252	2533	566		
44	873	2159	12814	2118	882		
45	50	63	349	233	125		
46			249	108			
47			683	323			
48			118	61			
49			604	289	67		
50		101	2083	1393	354		
51		46	2012	1403	366		
52		47	762	456	133		
53			1239	818	195		
54			242	226			
55			1760	924	129		
56		43	219	185	52		
57			106	166			
58		51	135	207			
59			127	51			
60			119	92	42		
61			505	307	59		
62			848	397	56		
63			1510	808	153		
64			641	296	50		
65			3560	1742	216		
66			4168	2025	218		
67			420	169			
68			140	96			
69							
70							
71							
72							
73			107	61			
74			224	164			
75			98	83			
76			74	58			
77			309	503	149		
78			170	191	49		
79			236	209	51		
80			63	44			
81			117				
82			46				
83							
84							
85							
86							
87							
88							
89			41				
90				45			
91			234	226	67		
92			83				
93			222	58			
94			1967	793	66		
95			106	64			
96			141				
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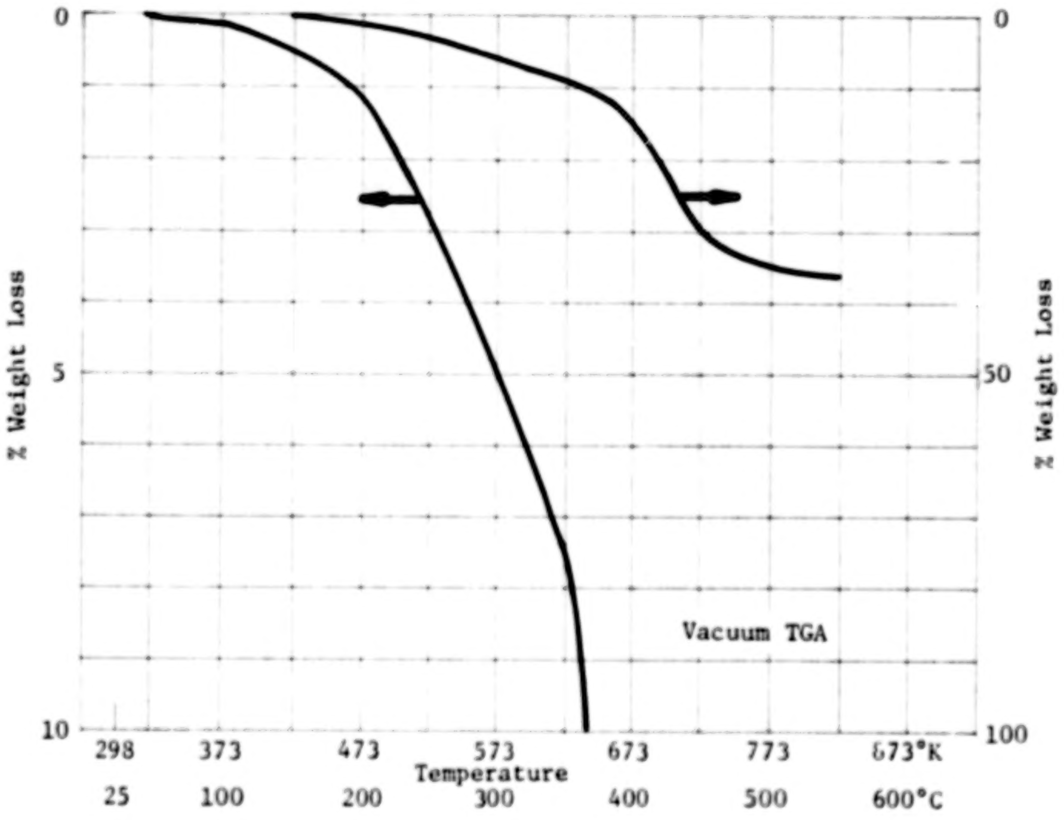
Chemical Characterization Summary

Mix Ratio: **As Received**
Cure: **2 hrs. at 422°K (149°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **633°K (360°C)-903°K (630°C)**

a_o = **30.6%** of initial weight

$$k = 2.15\times10^{13}\exp\left(\frac{-44400}{1.98\ T°K}\right)\ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec In Vac	In Nitrogen
323°K (50°C)	**3.9×10^{16}**	
373°K (100°C)	**3.6×10^{12}**	
423°K (150°C)	**2.9×10^{9}**	

Number and Relative Peak Intensity

Temperature, °K (°C) Laminate, E-787

m/e	298 (25)	473 (200)	573 (300)	673 (400)	798 (525)		
14	1265	730	750	1860	1110		
15	449	600	1010	2920	2090		
16	5823	3250	3500	9870	5500		
17	26763	20120	19360	29240	16970		
18	90667	76250	73200	100000	61220		
19	59						
20	280						
21							
22							
23							
24							
25	40		460	990			
26	145	450	2550	7990	1290		
27	295	1030	3450	8260	1270		
28	20601	18590	24150	56690	22790		
29	145			5610	800		
30	588	490	580	1030	640		
31				710			
32	4884	2770	2530	2600	2600		
33							
34							
35							
36							
37			630	720			
38	54	1280	1010	1070			
39			6590	3590	1210		
40	4684	3100	4220	4960	2960		
41	66		700	1480	470		
42	43			1600			
43	74			4940	400		
44	592	510	4360	47960	1490		
45				1130			
46							
47							
48							
49							
50		540	2150	810	420		
51		700	2840	570	580		
52		500	1890	580			
53			830	510			
54			540	420			
55				1350			
56				3310			
57				670			
58				510			
59				440			
60							
61							
62							
63			490	440	410		
64	52						
65	40		1020	780	430		
66	55		420	1220	530		
67				470			
68							
69							
70							
71							
72							
73							
74							
75							
76							
77		980	3890	590	490		
78			790				
79		2820	14310	630			
80		1380	6450				
81							
82							
83							
84	66						
85							
86							
87							
88							
89							
90							
91					450		
92							
93							
94				840			
95							
96							
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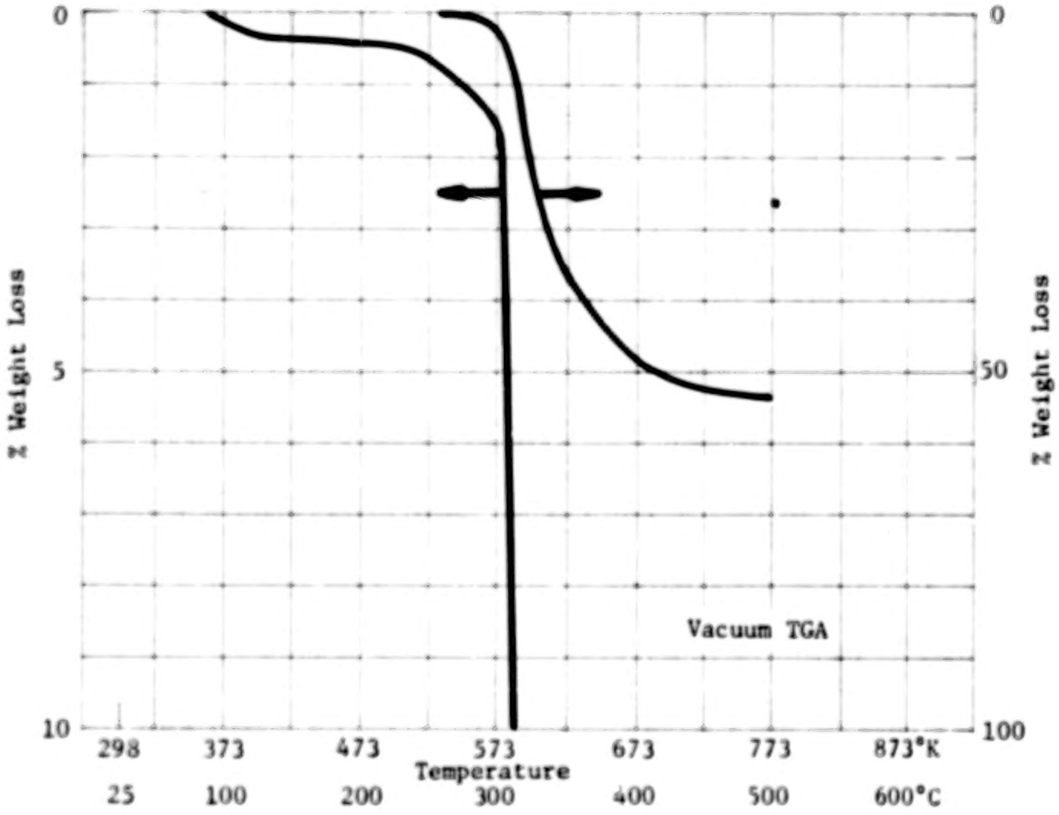
Laminate, G-10 **FR** Clad

Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C)-673°K (400°C)**

a_o = **50.0%** of initial weight

$$k = 3.30\times10^{45} \exp\left(\frac{-124800}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	9.5×10^{38}	
373°K (100°C)	4.2×10^{27}	
423°K (150°C)	8.9×10^{18}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Laminate, G-10 FR Clad

m/e	298 (25)	573 (300)	623 (350)	673 (400)	773 (500)		
14	599	773	952	690	840		
15	94	732	1018	336	303		
16	1368	1684	1851	1420	1475		
17	3504	3135	3267	2855	2920		
18	10530	8906	8775	7504	8010		
19	86	101	178	84	75		
20	55	50	60	56	56		
21							
22							
23							
24			102				
25		73	377	69	48		
26	53	329	1859	318	202		
27			2034	486	324		
28	2552	3221	4602	3395	3610		
29	59	317	1807	353	191		
30	322	366	511	428	451		
31			261				
32	854	825	900	917	1027		
33							
34							
35							
36				76	62		
37		104	1066	157	60		
38					108		
39		428	4833	761			
40	311	456	1880	537	458		
41		119	582	198	111		
42		201					
43				246			
44	180	1320	1411	318	278		
45		49	98	45			
46							
47			303	47			
48							
49				57			
50		190	1396	253	94		
51		160	1325	284	129		
52		124			55		
53		80	812	167	66		
54							
55		93	1148	176	65		
56		51	243	44			
57			79				
58		50	84				
59							
60							
61							
62					72		
63		125	1567	273	93		
64							
65		320	3920	521	146		
66		373	3820	465	125		
67		58	380	84			
68			159				
69							
70							
71							
72							
73							
74		46	460	103	42		
75			296	67			
76							
77		64	967	295	118		
78			484	147	72		
79		268		137	64		
80			141	58			
81		193					
82			40				
83							
84							
85							
86			60				
87			58				
88							
89			214	76			
90							
91		111	920	278	112		
92				103	51		
93							
94		1082	7160	860	197		
95			555	82			
96		381	121				
97							
98							
99							
100			43				
101							
102							
103			331	107	41		
104				66			
105				78	52		
106		71					
107			506	253	120		
108		96	138				
109							
110							
111							
112							
113							
114							
115			154	66			
116			77				
117				79			
118							
119			644	179	57		
120							
121			1368	412	93		
122							
123							
124							
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

Laminate, G-10 FR Clad

m/e	298 (25)	573 (300)	623 (350)	673 (400)	773 (500)		
128			84	51			
129			60	44			
130							
131			333	106	60		
132			231	72	47		
133							
134			661	171	54		
135					41		
136			365	113			
137			52				
138							
139							
140							
141							
142							
143							
144							
145			83	53			
146			47				
147			45				
148							
149							
150			110				
151							
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155							
156							
157			45				
158							
159			101	50			
160			44				
161							
162							
163							
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169							
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171							
172			140				
173							
174			114				
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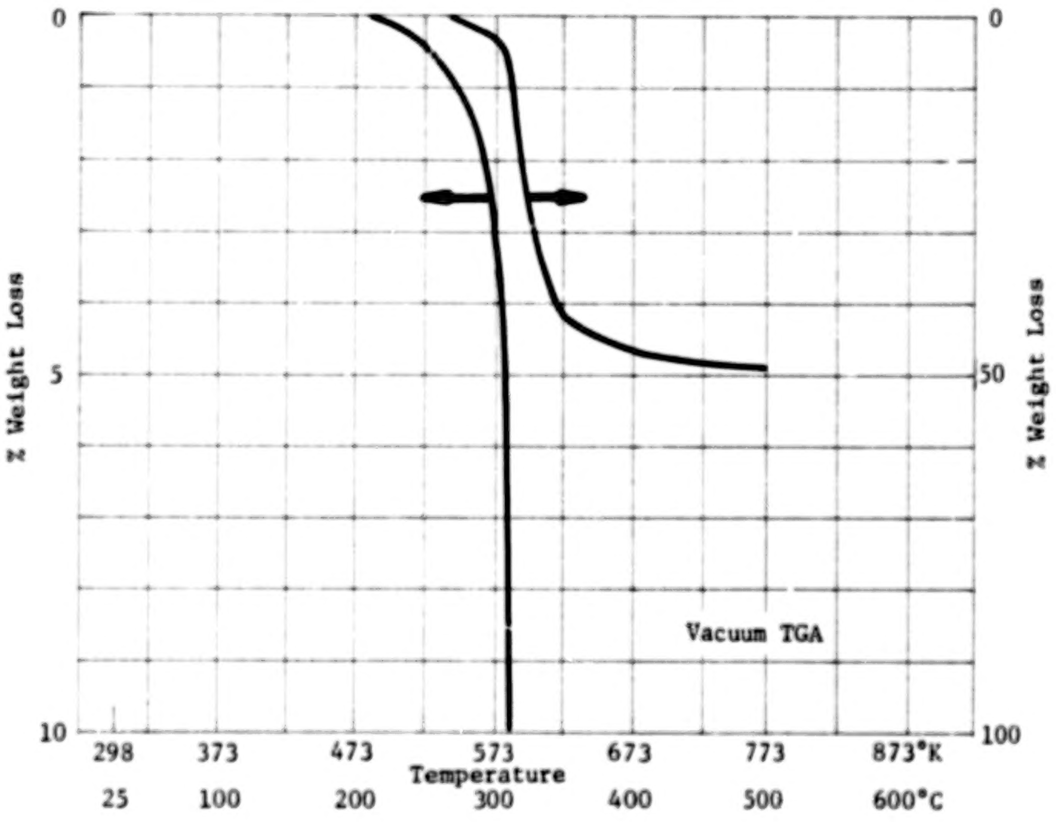
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C) - 723°K (450°C)**

a_o = 50.0% of initial weight

$$k = 9.78 \times 10^{36} \exp\left(\frac{-100{,}500}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.0×10^{31}	
373°K (100°C)	7.3×10^{21}	
423°K (150°C)	7.6×10^{14}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Laminate, G-10 FR Unbaked

m/e	298(25)	573(300)	623 (350)	673 (400)	773 (500)		
14	597	954	675	662	686		
15	77	1652	520	313	311		
16	1126	1829	1356	1229	1370		
17	2590	2949	2356	2306	2417		
18	7567	7956	6156	6092	6554		
19	96	106	120	88	72		
20		45	49		50		
21							
22							
23							
24		50					
25		140	123	66	43		
26	41	632	573	338	206		
27		667	739	437	354		
28	1930	3339	2797	2788	3098		
29	55	602	580	330	227		
30	254	335	368	353	400		
31				64			
32	649	634	673	704	825		
33							
34							
35							
36		57		56			
37		245	286	147	50		
38		417			118		
39		920	1423	686	293		
40	238	577	658	663	299		
41		200	251	145	111		
42		247	198	124	81		
43			337	207			
44	141	2245	480	275	235		
45		76	52				
46		49					
47		64	66	44			
48							
49							
50		318	426	229	109		
51		272	458	254	139		
52		164		118	67		
53		154	265	142			
54							
55		233	300	168	66		
56		99	52				
57		43	40				
58		98					
59							
60							
61		127	200	106			
62		230					
63		281	478	256	110		
64							
65		784	1039	461	173		
66		856	976	452	140		
67		98	119	71			
68		47	53				
69							
70							
71							
72							
73		75					
74		92	148	90	42		
75		62	108	67			
76		56					
77		83	412	255	138		
78			191	125	83		
79		389	172	106	72		
80			63	48			
81		288					
82		55					
83							
84							
85							
86							
87							
88							
89			89	64	40		
90							
91		142	411	209	131		
92			168	82	50		
93							
94		2350	1649	790	218		
95			150	81			
96		462	48				
97							
98							
99							
100							
101							
102							
103			147	86	45		
104							
105			89	53	62		
106		51					
107			256	221	169		
108		81	69	84			
109							
110							
111							
112							
113							
114							
115			61	50			
116							
117			48				
118							
119		40	280	131	66		
120							
121			627	300	108		
122			96	71			
123							
124							
125							
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Laminate, G-10 FR Shaded

m/e	298 (25)	573 (300)	623 (350)	673 (400)	773 (500)		
128				61			
129			56	67			
130							
131			87	71	52		
132			79	53			
133							
134			292	136	52		
135					44		
136			173	92			
137							
138							
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140							
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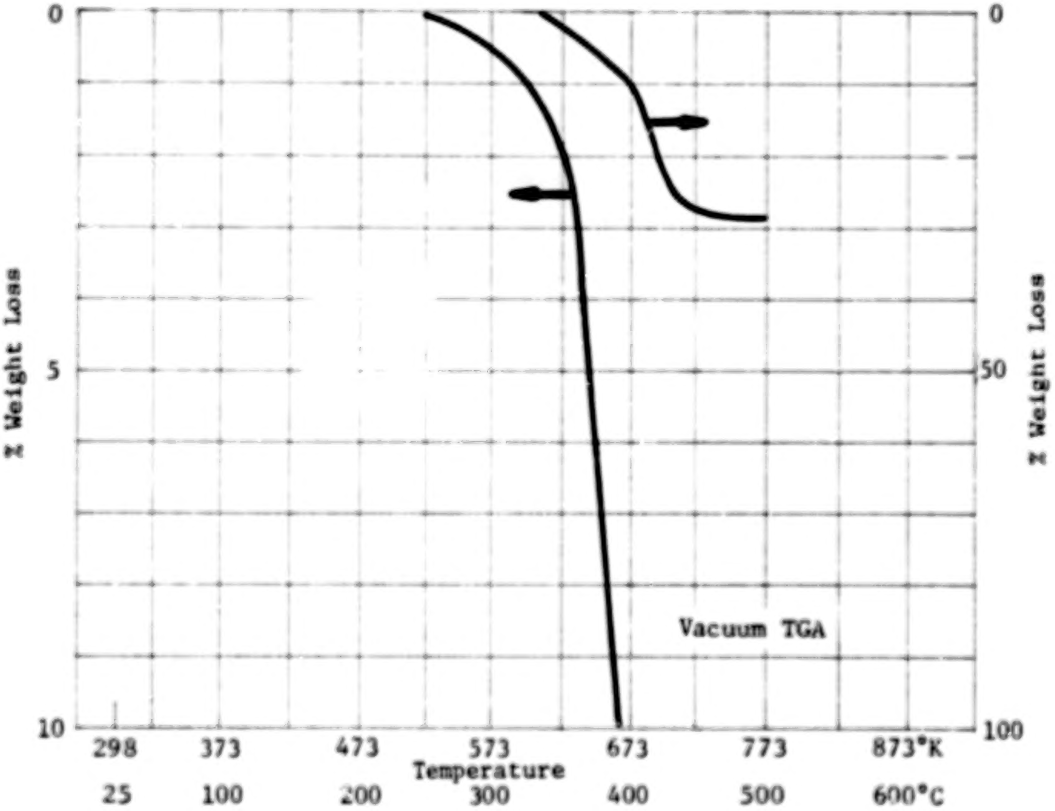
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-723°K (450°C)**

a_o = **27.8%** of initial weight

$$k = 8.78\times10^{11} \exp\left(\frac{-38900}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.8×10^{14}	
373°K (100°C)	5.1×10^{10}	
423°K (150°C)	1.0×10^{8}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Laminate, L-P-509 GR G-11

m/e	298 (25)	473 (200)	623 (350)	723 (450)	823 (550)		
14	784	727	1186	1006	945		
15	338	475	1755	900	817		
16	1812	1488	2945	1952	2060		
17	13134	8978	10335	9384	8224		
18	48868	35522	35768	32791	30201		
19	422	507	418	372	299		
20	99	123	69	75	73		
21							
22							
23							
24							
25	43	54	329	263	71		
26	625	611	2442	2089	1380		
27	1592	1571	3854	3334	1858		
28	23476	[illegible]	28886	23879	22531		
29	1709	[illegible]	4093	3169	1897		
30	456	430	1415	619	420		
31	5818	6474	5407	4192	3724		
32	6041	5800	5517	5337	5307		
33							
34							
35							
36			41				
37			453	446	73		
38			917	949	184		
39	63	57	3384	4251	1151		
40	537	489	2048	1877	881		
41	93	138	1467	1055	429		
42	171	174	2985	883	346		
43	601	722	3050	2766	1277		
44	717	857	10252	1805	1091		
45	2333	2569	2810	2232	1580		
46	755	926	867	485	481		
47			75	115			
48							
49			77	92			
50			1006	1046	268		
51			732	1328	286		
52			441	285	50		
53			439	634	100		
54			278				
55			798	810	180		
56			594	130	48		
57			235	88			
58			378	106			
59			56				
60							
61			75	83			
62			146	207	46		
63			424	875	106		
64			70	118			
65			1545	2056	421		
66			1963	2303	419		
67			149	79	41		
68			169	44			
69			40				
70			49				
71							
72							
73			45	45			
74				107			
75				61			
76							
77			105	1329	215		
78			73	320	68		
79			146	388	83		
80			95	45			
81			59				
82			61				
83							
84							
85							
86							
87							
88							
89				74			
90							
91			135	902	326		
92				91	51		
93			126				
94				42			
95			3281	2527	443		
96			120	57			
97							
98							
99							
100							
101							
102							
103							
104				80			
105							
106				69			
107							
108				405	52		
109				103			
110							
111							
112							
113							
114							
115							
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117							
118							
119							
120				108			
121							
122				215			
123							
124							
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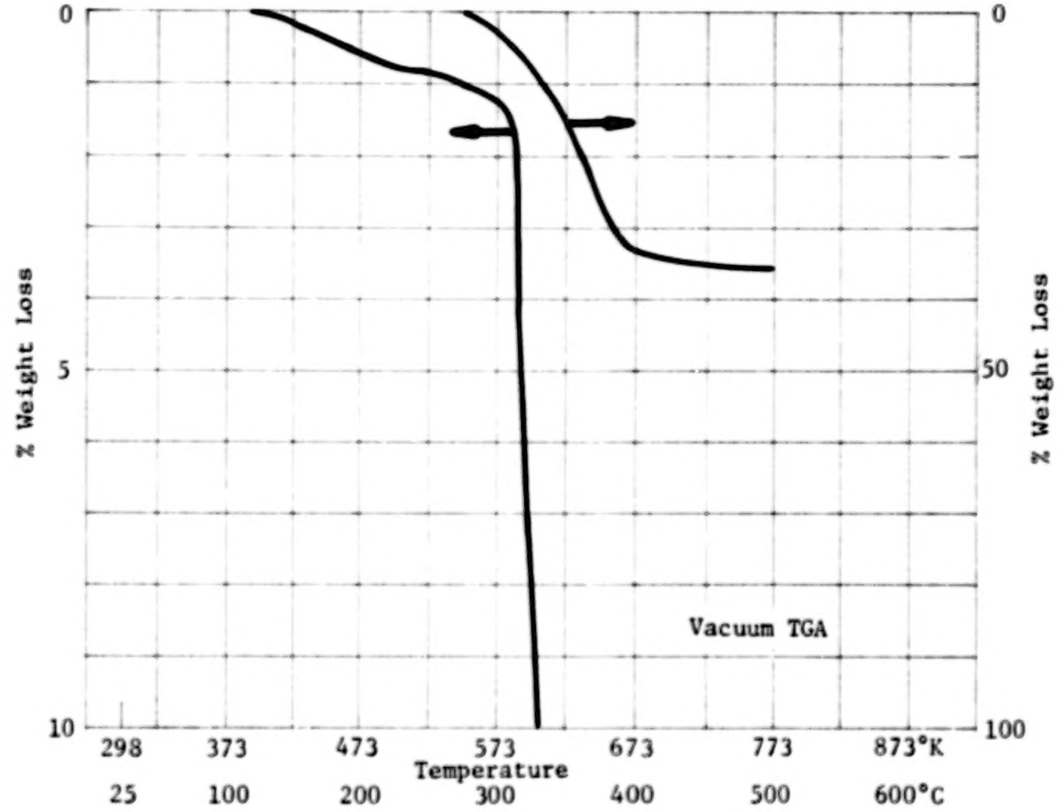
127							

Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 4.5 pbw Activator**
Cure: **1 hr. at 322°K (49°C), 2 hrs. at 366°K (93°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C) - 673°K (400°C)**

a_o = **35.5% of initial weight**

$$k = 1.74\times10^{20} \exp\left(\frac{-58{,}800}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**3.1×10^{19}**	
373°K (100°C)	**1.4×10^{14}**	
423°K (150°C)	**1.1×10^{10}**	

Number and Relative Peak Intensity

Temperature, °K (°C) LCA-4V/BA-5

m/e	298 (25)	523 (250)	623 (350)	723 (450)			
14	469	354	1912	503			
15	83	232	4914	539			
16	1737	1431	3988	2007			
17	8910	6043	11527	4884			
18	32718	21546	41468	16903			
19			40				
20	63	42	152	50			
21							
22							
23							
24			641				
25			3003	102			
26	115	195	15617	1254			
27	221	275	16039	1685			
28	18853	16811	43101	18064			
29	105	479	10000	812			
30	85	120	4971	305			
31		45	3230				
32	4967	4102	4095	3658			
33			191				
34							
35							
36			538				
37			6269	103			
38			11853	288			
39			40369	2026			
40	1465	1480	17252	2114			
41	40	47	8478	837			
42		64	9165	378			
43		173	11428	528			
44	314	1316	14238	1298			
45			2440				
46			388				
47			2176				
48			186				
49			2137				
50			11060	352			
51			12337	741			
52			7447	128			
53			4692	333			
54			1842	59			
55			8836	163			
56			2673	61			
57			1217				
58			1869				
59			637				
60			569				
61			2599				
62			5009	89			
63			9274	297			
64			3089	772			
65			23541	518			
66			26206	872			
67			3643	66			
68			1462				
69			390				
70			357				
71			172				
72			203				
73			686				
74			2461				
75							
76							
77			8374	673			
78			2588	76			
79			3767	205			
80			1706	58			
81			607				
82			190				
83			43				
84			129				
85			102				
86			92				
87			161				
88							
89			1325				
90			634				
91			7392	386			
92			890				
93			1714				
94			32722	620			
95			138				
96			2166				
97			131				
98							
99			45				
100							
101			74				
102			130				
103			1016				
104			98				
105			899				
106			156				
107			3023	256			
108			1167	49			
109			68				
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113							
114							
115							
116			181				
117							
118			76				
119			101				
120			3332				
121			289				
122			2094	49			
123			231				
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) LCA-4V/BA-5

m/z	298 (25)	523 (250)	623 (350)	723 (450)			
128							
129							
130							
131							
132			45				
133							
134			178				
135			1599				
136			55				
137							
138			77				
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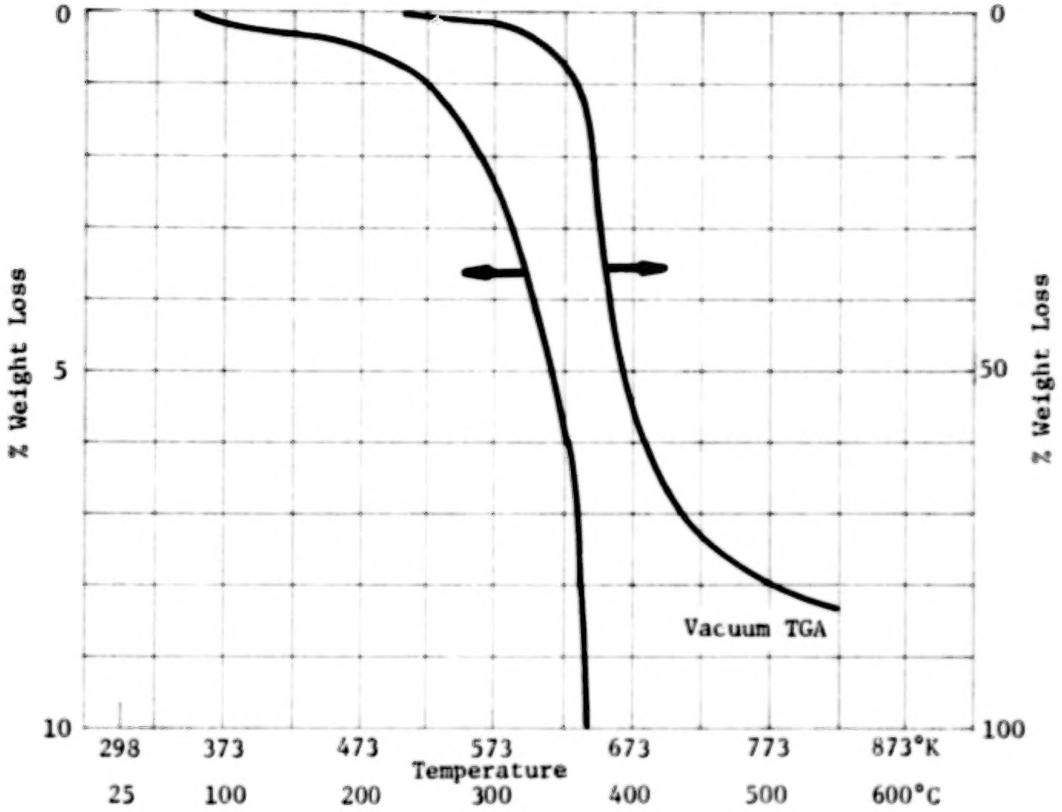
Lefkoweld 46LM 52

Chemical Characterization Summary

Mix Ratio: **100 pbw resin to 74 pbw activator**
Cure: **24 hrs. at room temperature**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-823°K (550°C)**

a_o **= 83.9%** of initial weight

$$k = 1.33\times10^{4} \exp\left(\frac{-16,800}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**1.1×10^7**	
373°K (100°C)	**3.2×10^5**	
423°K (150°C)	**2.2×10^4**	

Number and Relative Peak Intensity

Temperature, °K (°C)

Lefkowald 4RGM 52

m/e	298 (25)	523 (250)	623 (350)	723 (450)	873 (550)		
14	1629	1332	5501	2893	2493		
15	379	518	11965	4909	3432		
16	4450	4329	17768	7909	7466		
17	18678	16439	51324	18429	17526		
18	58378	53955	100696	61654	59162		
19	127	130	595	220	106		
20	363	290	744	489	402		
21							
22			57				
23							
24		42	1222	530	205		
25		111	4598	2216	839		
26	244	845	27198	12382	4550		
27	564	1286	33136	23203	6395		
28	23212	22993	63377	45447	33103		
29	309	1074	21113	15583	2790		
30	835	1042	16678	4248	1995		
31	47	358	8901	745	331		
32	5199	4374	4913	5420	4949		
33			81				
34			45				
35			51				
36			1006	264	70		
37		83	7155	1743	473		
38		127	11703	3613	989		
39	71	621	37276	18834	4225		
40	4217	4416	23933	11333	6814		
41	51	407	25556	25050	4228		
42	52	307	23197	11892	2436		
43	78	597	12331	19143	1951		
44	678	1182	13502	3787	1524		
45			2435	353	194		
46			292	90			
47			939	194	47		
48			273	124			
49			1350	725	142		
50			5820	3352	792		
51		44	6739	4512	1074		
52		50	6062	2365	606		
53		51	7026	4057	743		
54		65	3364	2748	583		
55		67	5713	9361	1442		
56		59	4675	7404	960		
57		416	7407	7158	509		
58		109	4381	1036	157		
59			843	181			
60			342	149	43		
61			978	351	90		
62			1757	944	149		
63			3141	2182	492		
64			1588	756	112		
65			7506	3557	790		
66			10588	2346	525		
67		61	8598	2807	515		
68			1382	1262	217		
69			1048	2512	291		
70			917	2796	238		
71			738	2160	108		
72			388	344	57		
73			322	55	41		
74			721	465	84		
75			433	397	102		
76			379	352	56		
77			1781	3551	678		
78			1060	1054	299		
79			1612	2396	354		
80			2530	745	162		
81			1134	1305	212		
82			260	820	102		
83			327	870	78		
84			337	810	78		
85			225	963			
86			153	246			
87			82	89			
88							
89			414	417	52		
90			327	246	43		
91			1160	2926	629		
92			448	531	73		
93			1419	874	77		
94			18253	2354	529		
95			1522	684	150		
96			239	325			
97			119	303	47		
98			59	289			
99			62	110			
100			67	97			
101			72	76			
102			46	115			
103			157	499	73		
104			61	135			
105			211	678	97		
106			286	245	51		
107			2034	1533	243		
108			2271	639	110		
109			322	198	40		
110			61	95			
111			44	74			
112			116	70			
113			43	41			
114				49			
115			118	327	60		
116				78			
117			69	181			
118			287	118	44		
119			787	1101	176		
120			414	274	50		
121			1524	1236	136		
122			829	343			
123			113	49			
124				59			
125							
126				53			
127				47			

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	523 (250)	623 (350)	723 (450)	823 (550)		
128				97			
129				66			
130				48			
131			123	209			
132			92	105			
133			367	371	69		
134			815	1019	147		
135			260	362			
136			339	278			
137				45			
138							
139							
140							
141							
142							
143				69			
144				45			
145				105			
146				60			
147				90			
148				75			
149				98			
150				48			
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159				46			
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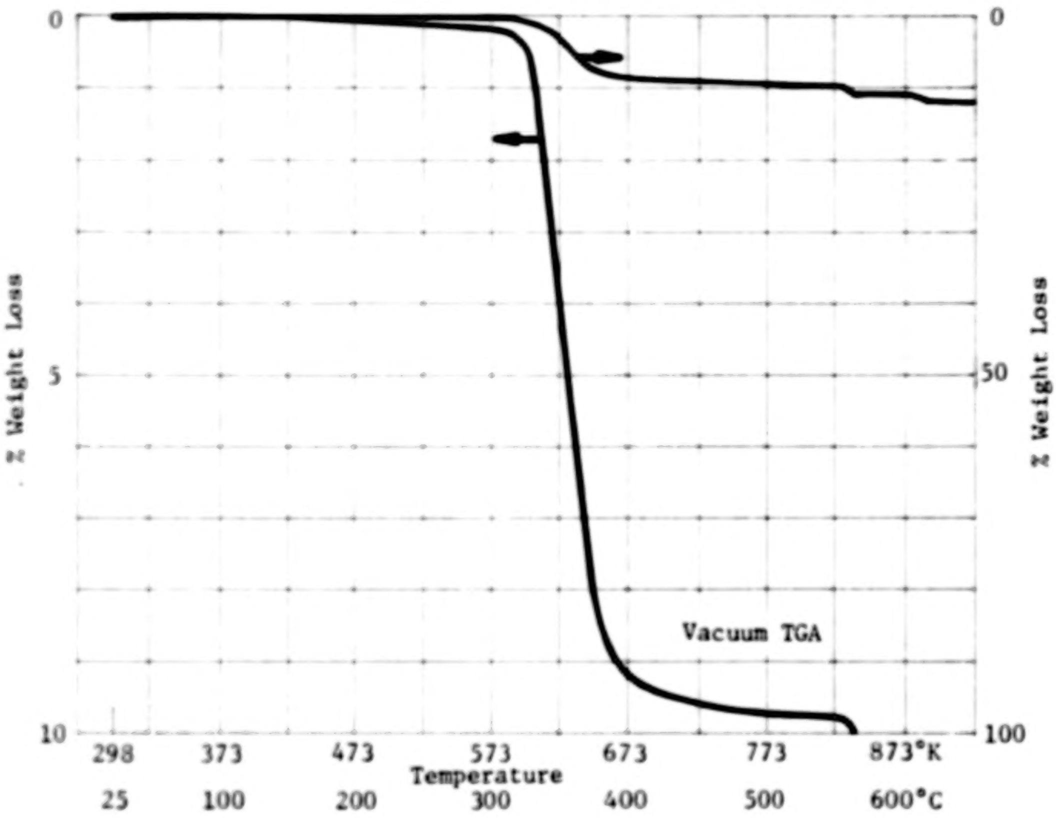
Chemical Characterization Summary

Mix Ratio: **As received**
Cure: **As received**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **573°K (300°C)-673°K (400°C)**

a_o = **10%** of initial weight

$$k = 1.6\times10^{34} \exp\left(\frac{-98000}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	1.5×10^{32}	
373°K (100°C)	1.8×10^{23}	
423°K (150°C)	2.3×10^{16}	

Isothermal weight loss in nitrogen - 0.15%

Number and Relative Peak Intensity

Temperature, °K (°C) MF500F-124 Microwave Absorber

m/e	298(25)	473(200)	598(325)	623(350)	698 (425)	873 (600)	
14	3665	3609	5188	6977	3645	14412	
15	1758	1914	6625	11999	2691	2051	
16	12791	11836	13976	16109	11762	11340	
17	41235	34062	36223	47133	29646	27750	
18	100799	100254	100843	100855	83628	75849	
19	294	293	469	562	186	141	
20	853	846	881	935	706	829	
21							
22							
23							
24			533	1011	44		
25	89	99	2099	4038	389	159	
26	898	1209	10028	18363	2563	1916	
27	1923	2201	10618	20259	3347	3842	
28	43992	42441	62238	63998	32814	100918	
29	635	720	7369	12470	1525	1691	
30	2219	2267	3431	3992	2228	2566	
31		51	3379	2702	164	45	
32	10135	9372	8763	8964	8224	8569	
33			118	70			
34							
35							
36			388	818			
37			3155	6521	423		
38		56	5670	12729	1018	61	
39	148	326	17201	43732	3556	305	
40	7732	7954	14968	22343	8490	8868	
41	124	512	7369	9931	1226	362	
42	75	637	7757	5818	718	185	
43	148	383	6981	9628	877	314	
44	2365	2908	13648	7115	2392	2531	
45			1884	1229	63		
46			496	596			
47			1309	1935	59		
48			184	280			
49			1203	2120	91		
50			4907	10679	912		
51			4034	12580	1010	60	
52			1351	3809	316		
53			2453	6914	546		
54			639	1017	54		
55			4628	8168	592		
56			925	970	73		
57			2076	1392			
58			1538	1344			
59			169	551			
60			348	858			
61			1409	2334	71		
62			2166	4703	241		
63			3981	9531	652		
64			1365	3003	185		
65			12489	21886	1648		
66	46		17004	21863	1707	84	
67			1520	2370	142		
68			927	917			
69			317	156			
70			398	136			
71			376	65			
72			144				
73			356	526			
74			1098	2356	92		
75			499	1483			
76			378	924			
77			1660	11636	923		
78			731	2752	296		
79			889	3393	386		
80			209	[illegible]			
81			116	248			
82			71	47			
83			41				
84	88	88	180	122	55	86	
85							
86			92	157			
87				136			
88							
89			146	1557	40		
90			81	621			
91			1348	11075	672		
92			235	1341			
93			944	2177	49		
94			26761	[illegible]	2163		
95			1692	1761	52		
96			80	53			
97							
98		63	1417	222			
99		85	1799	245			
100			46				
101				124			
102				783			
103			410	2817	64		
104				274			
105			179	1445	41		
106				129			
107			614	3018	473		
108			231	476	167		
109							
110							
111							
112							
113							
114							
115			81	635			
116				55			
117				176			
118			41	212			
119			436	5269	186		
120			60	831			
121			2172	9899	401		
122			238	829			
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) MF500F-124 Microwave Absorber

m/e	298 (25)	473 (200)	598 (325)	623 (350)	698 (425)	873 (600)	
128							
129	119	126	93	94	88	112	
130							
131	68	50	96	193	76	87	
132	96	104	105	114	82	77	
133			51	724			
134			456	3962	128		
135				426			
136			278	1501			
137							
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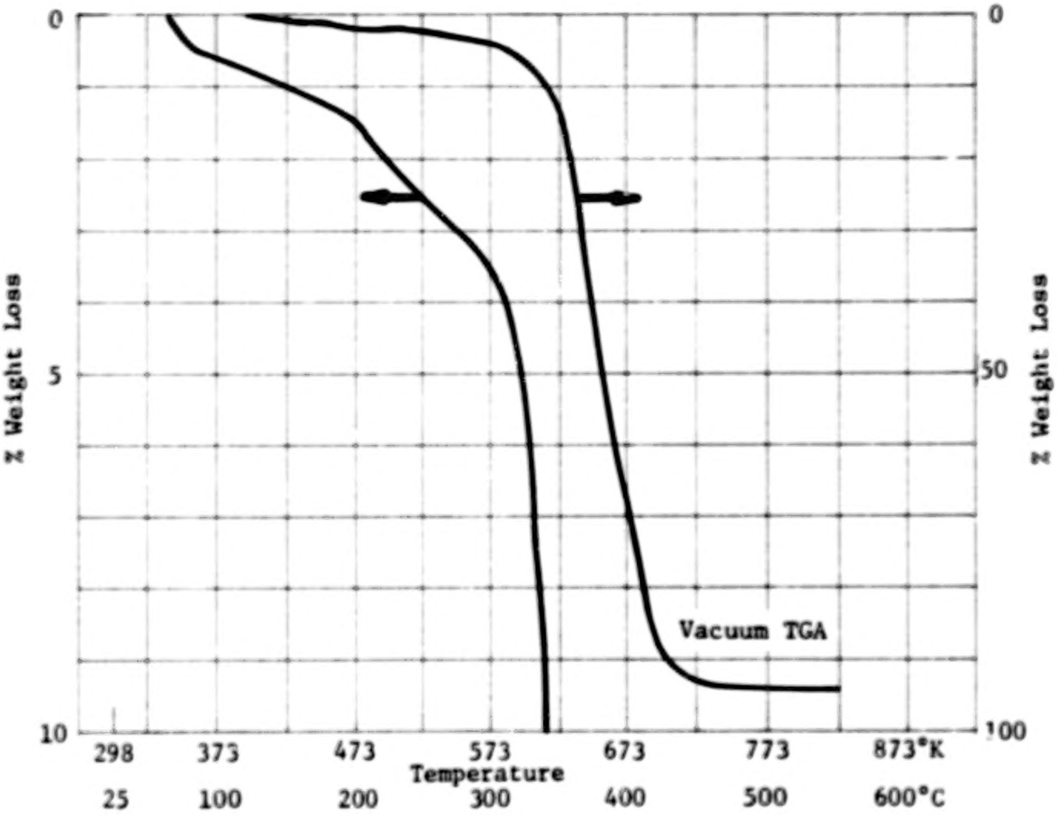
Paint, Cat-A-Lac
473-3-1/x304

Chemical Characterization Summary

Mix Ratio: 3 pbv resin to 1 pbv activator
Cure: 24 hrs. at 338°K (65°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 473°K (200°C) - 723°K (450°C)

a_o = 92.2% of initial weight

$$k = 6.93\text{x}10^{13} \exp\left(\frac{-43{,}100}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.7×10^{15}	
373°K (100°C)	2.0×10^{11}	
423°K (150°C)	2.0×10^{8}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Paint, Cat-A-Lac 473-3-1/x306

m/e	298 (25)	423 (150)	523 (250)	623 (350)	673 (400)	773 (500)	
14	1025	1053	1174	2536	2381	1508	
15	431	568	1026	5509	3942	1941	
16	3390	3396	4712	5985	5057	4300	
17	10516	9727	10900	14572	10393	8459	
18	31821	28783	154	42692	29961	23033	
19	121	120	251	194	217	103	
20	242	256		318	300	270	
21							
22				46			
23							
24	42		49	278	278	104	
25		72	138	939	1016	310	
26	219	375	763	4559	4527	1468	
27	425	706	1636	5797	5136	1832	
28	10371	10648	11881	20798	18320	13134	
29	195	469	1174	4479	4908	1244	
30	778	858	950	3830	1915	1123	
31	51	209	1184	1206		208	
32	2851	2809	2728	2795	2772	2641	
33			102	88			
34							
35				67			
36	69	71	85	252	323	112	
37			83	1059	1912	268	
38	41	70	150	1939	3462	477	
39	66	211	634	5505	10124	1522	
40	1853	1934	2062	4576	5789	3386	
41	63	340	1350	2666	1871	621	
42	60	174	755	5577	1782	497	
43	84	676	1511	4258	4870	913	
44	645	837	2696	6554	3113	1043	
45		78	268	1490	678	153	
46				123	194	41	
47				357	683	70	
48				98	125		
49			41	379	601	115	
50		51	128	1697	2676	488	
51		47	85	1569	2927	642	
52			70	1093	1005	262	
53		41	96	1218	1773	338	
54			72	776	456	118	
55		96	378	1444	2308	309	
56		185	1002	1631	448	139	
57		155	434	1070	951	133	
58		49	98	1368	727	127	
59			45	445	164	43	
60				494	405	80	
61				317	737	106	
62			88	532	1243	198	
63				963	2321	413	
64				407	767	145	
65			49	2288	5438	668	
66		44	55	2081	6544	573	
67			71	971	710	118	
68				454	365	73	
69			99	235	129	43	
70			53	306	101		
71		55		279	68		
72				226	106	44	
73			40	191	218	45	
74				307	654	128	
75				166	371	90	
76				149	295	78	
77			43	631	2131	563	
78				381	702	224	
79			40	536	1076	254	
80				708	333	84	
81				341	172	57	
82			45	222	104	41	
83		51	53	133	57		
84	49		65	168	97	62	
85		54	114	128	61		
86				81	86	40	
87				80	76		
88							
89				146	400	108	
90				116	337	85	
91				477	1457	533	
92				169	268	103	
93				342	458	79	
94				4813	9534	759	
95				523	716	79	
96				97	86		
97				95			
98				52			
99				41			
100							
101					50		
102					94	48	
103				88	388	126	
104				57	99	56	
105				118	281	196	
106				120	80	72	
107				370	1400	367	
108				441	686	186	
109				147	91		
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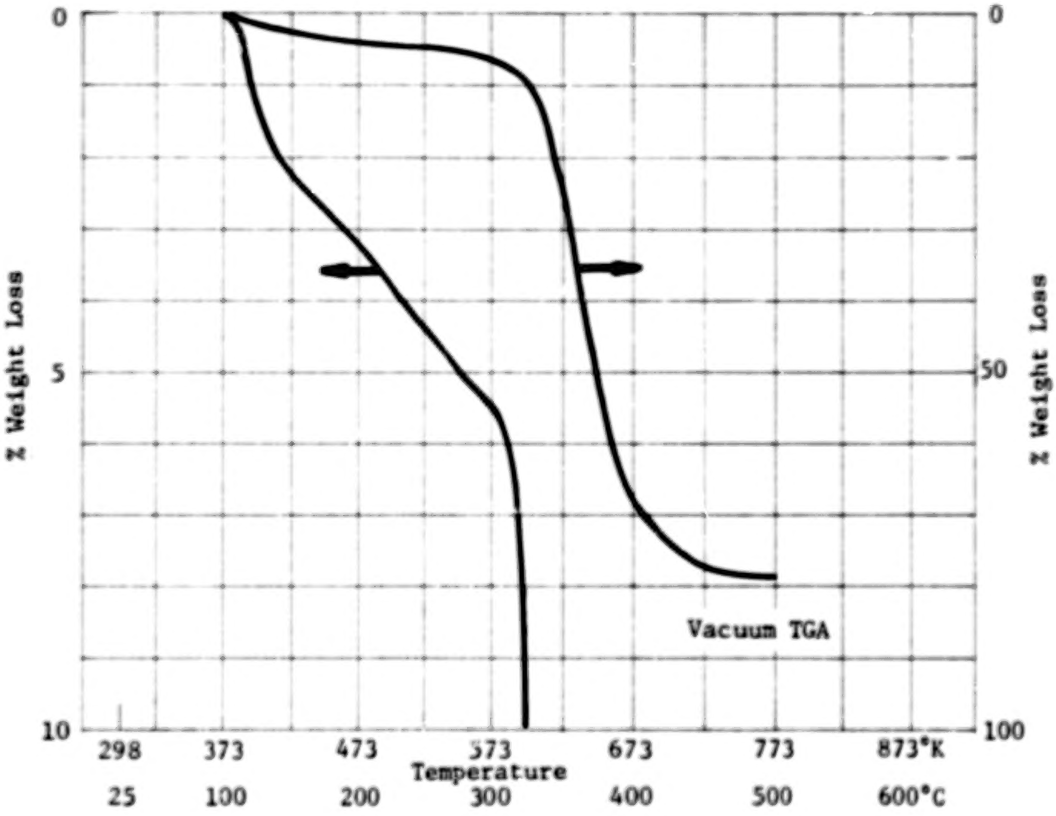
Chemical Characterization Summary

Mix Ratio: 1 pbv resin to 1 pbv activator
Cure: Room temperature

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 573°K (300°C)-703°K (430°C)

a_o = 29% of initial weight

$$k = 4.8 \times 10^{21} \exp\left(\frac{-61,600}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	8.6×10^{19}	
373°K (100°C)	2.1×10^{14}	
423°K (150°C)	1.1×10^{10}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Paint, [illegible] Gloss Black Enamel

m/e	298(25)	473(200)	623(350)	673(400)	773(500)		
14	2185	4324	22320	19406	5876		
15	389	7634	58760	51390	13835		
16	3475	12232	25970	22620	10199		
17	11727	21211	51110	30500	11722		
18	37335	41235	155230	97250	33252		
19	110	1576	1370	730	102		
20	169	201			388		
21							
22							
23							
24		258	2110	1720	279		
25	45	1124	11310	9320	1237		
26	272	7010	57000	66660	6446		
27		17403	76350	60960	7631		
28	21864	35166	117030	102890	38372		
29	275	19150	62890	49680	3181		
30	540	3380	18670	8750	2181		
31	49	31261	20830	7700			
32	4711	5321	7890	6280	4517		
33		1765					
34		57					
35							
36		42	2320		70		
37		390	24440	16800	553		
38		798	44650	28770	1153		
39	65	4592	143590	100180	4443		
40	1027	2417	57970	33870	2597		
41	51	13612	30270	25020	2034		
42	56	6910	32970		1246		
43	83	14955	58010	56470	1142		
44	422	3914	30060	12975	1302		
45		5101	16020	3770	367		
46		191	1960	1100	55		
47			8710	4010	42		
48			730	420	48		
49		101	6020	3760	175		
50		505	32000	22900	1350		
51		376	36460	30150	1956		
52		143	13450	9220	762		
53		314	21780	15580	768		
54		164	5930	2200	176		
55		2543	30000	18060	609		
56		9017	8980	2460	239		
57		1559	5900	3460	250		
58		251	5640	4890	178		
59		4793	4260	950	72		
60		169	4140	1410	76		
61		162	7490	8520	119		
62		139	13630	19060	358		
63			26670	5680	936		
64		41	8430	3800	285		
65		85	66760	41710	1314		
66	45	68	82720	40800	830		
67		161	8450	3760	177		
68		58	3520	1070	74		
69		170	800		69		
70		67	710		42		
71		106	610				
72		1198	1060				
73		156	2210	700	65		
74		111	6560	3910	185		
75			2990	2140	109		
76			2220	1780	129		
77		78	20520	24240	1234		
78			6140	6450	750		
79		53	10740	8660	540		
80			3810	970	89		
81		56	1350	440	72		
82			430		44		
83		64					
84		128			85		
85		120	550				
86					59		
87					42		
88							
89			2790	2280	159		
90			2220	1410	104		
91		85	15190	18090	1909		
92			1780	1790	443		
93			3570	3000	78		
94			97500	43010	695		
95			7300	2990	70		
96							
97							
98							
99							
100							
101							
102				450	44		
103			1960	3870	103		
104				500	58		
105			1480	2130	290		
106					149		
107			11350	11490	506		
108			4540	2780	173		
109							
110							
111							
112							
113							
114							
115			690	990	71		
116							
117							
118			450	500	43		
119			5500	3590	84		
120			740				
121			4840	760	40		
122			680	11720	112		
123				930			
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Paint, Brolite Gloss Black Enamel

m/e	298 (25)	473 (200)	623 (350)	673 (400)	773 (500)		
128							
129							
130							
131							
132							
133							
134			850				
135			2210	990			
136			420				
137				510			
138							
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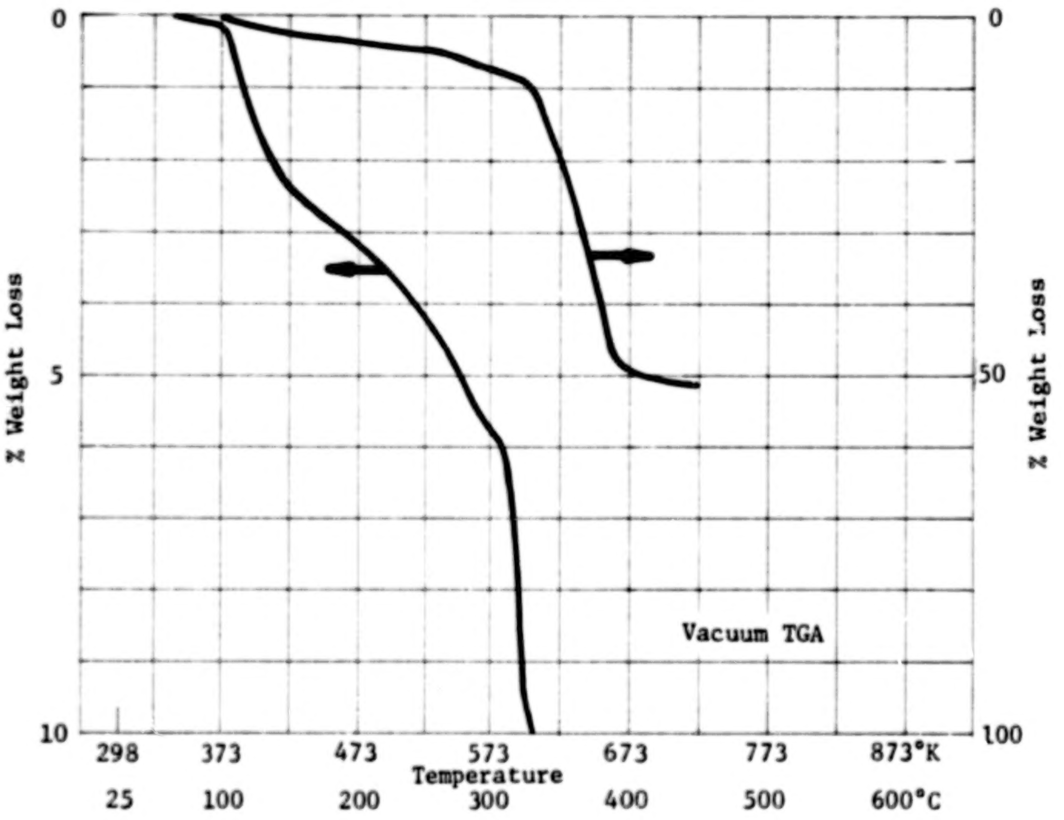
Paint, Brolite Gloss
White Enamel

Chemical Characterization Summary

Mix Ratio: **1 pbv resin to 1 pbv activator**
Cure: **Room temperature**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **578°K (305°C)-773°K (500°C)**

a_o = **20%** of initial weight

$$k = 2.6 \times 10^{25} \exp\left(\frac{-72{,}600}{1.98\ T^\circ K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	4.6×10^{23}	
373°K (100°C)	1.1×10^{17}	
423°K (150°C)	1.0×10^{12}	

Number and Relative Peak Intensity

Temperature, $^\circ$K ($^\circ$C)

Paint, Brolite Gloss White Enamel

m/e	298 (25)	523 (250)	623 (350)	673 (400)			
14	2248	8842	36210	10300			
15	269	20962	98340	23070			
16	3822	23162	45160	17270			
17	15964	34943	109800	27130			
18	53773	74881	351380	87170			
19	391	1632	2330				
20	188	413	670				
21							
22		354					
23							
24		637	4080	730			
25		2363	19380	4610			
26	185	13959	97800	25270			
27		32032	141910	33190			
28	22115	71716	184360	66600			
29	242	39356	110850	18730			
30	522	7609	28830	3950			
31		27445	27050	2460			
32	5479	6027	12460	5370			
33		2990					
34		141	740				
35		56					
36		46					
37		1119	46770	6150			
38		2124	88550	12360			
39		9387	272180	48090			
40	883	4725	108360	15490			
41		23441	55590	14160			
42		19032	56790	6650			
43	45	40550	85270	17470			
44	494	39944	48090	5740			
45		3302	15600	960			
46		361	3680				
47		101	17650	990			
48		81	1610				
49		339	11260	1390			
50		1778	58810	11080			
51		911	67710	15610			
52		735	22870	4760			
53		792	40540	7700			
54		738	11110	960			
55		5033	60610	7760			
56		16894	18720	1100			
57		3815	10370	1070			
58		1379	8670	750			
59		472	3150	820			
60		242	6130				
61		66	14590	1170			
62		407	25890	3610			
63		77	50050	9850			
64		82	16080	2400			
65		160	127630	17570			
66		147	156550	16340			
67		222	1577	1280			
68		219	7550	420			
69		368	2070				
70		218	1320				
71		149	910				
72		346	1000				
73		206	3630				
74		315	12120	1360			
75			6268	840			
76			4670	670			
77		93	36020	11680			
78		57	10990	2930			
79		85	18590	4000			
80		52	6800	480			
81		61	2620				
82		74	830				
83		87	440				
84		234	510				
85		360	1020				
86		139	580				
87		104	590				
88							
89			5450	910			
90			3990	590			
91		158	28270	8600			
92			4000	660			
93			7190	690			
94		112	186600	15890			
95		63	14210	750			
96							
97							
98							
99							
100		87					
101							
102			630				
103			4010	970			
104			590				
105			3440	570			
106			760				
107			18990	4990			
108			7320	990			
109			440				
110							
111							
112							
113							
114							
115			1760	470			
116							
117			460				
118			750				
119			10230	1440			
120			1630				
121			8430	3270			
122			1260				
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

Paint, Brolite Gloss White Enamel

m/e	298 (25)	523 (250)	623 (350)	673 (400)			
128							
129							
130							
131							
132							
133			440				
134			550				
135			4640	470			
136			930				
137			420				
138							
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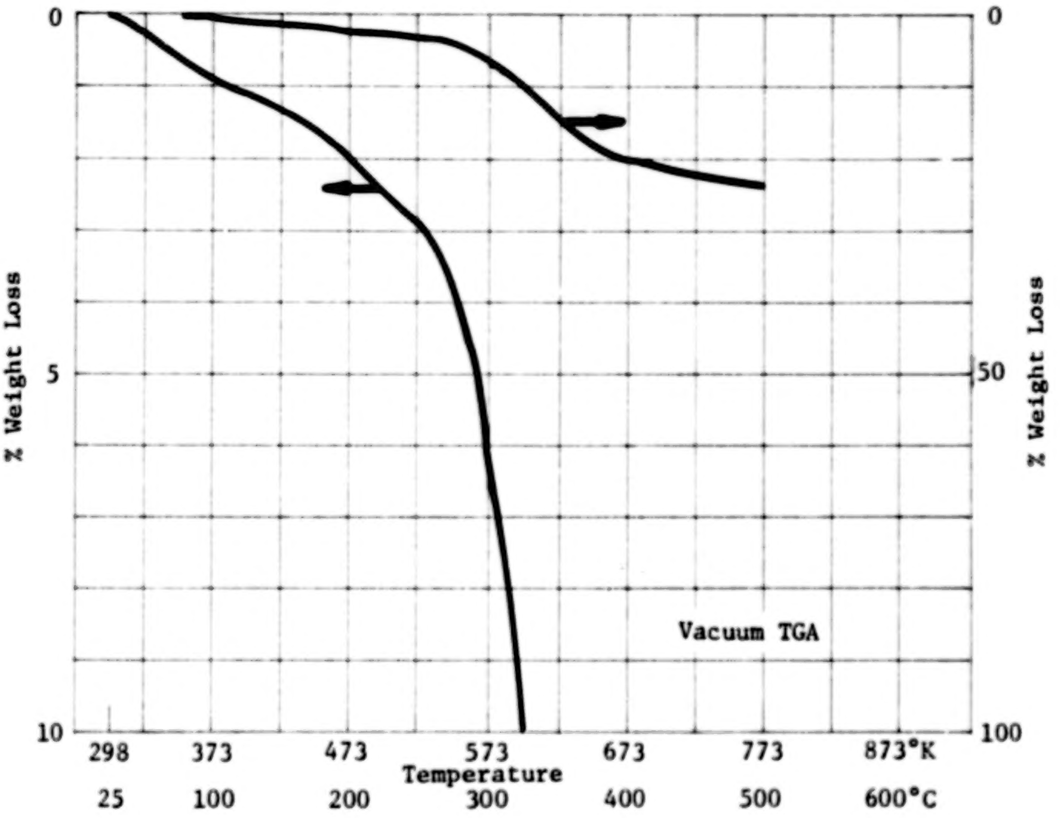
Chemical Characterization Summary

Mix Ratio: 3 pbv resin A to 1 pbv activator B
Cure: 2 hrs. at 298°K (25°C), 16 hrs. at 383°K (111°C)

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: 473°K (200°C)-773°K (500°C)

a_o = 22.8% of initial weight

$$k = 5.47\times10^{6} \exp\left(\frac{-20800}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.6×10^7	
373°K (100°C)	2.0×10^5	
423°K (150°C)	7.1×10^3	

Number and Relative Peak Intensity

Temperature, ^{0}K (^{0}C) Paint, Nextel 401-C10

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	2340	2142	2543	2778	2287		
15	523	1047	1711	1791	1337		
16	4382	4089	5150	5156	4872		
17	18103	14153	15614	15631	13295		
18	62058	47168	52326	51346	43915		
19	233	287	292	247	253		
20	285	275	425	397	330		
21							
22							
23							
24			108	93			
25		91	550	598	213		
26	315	796	2668	3125	1418		
27	376	1000	3218	4563	1791		
28	24385	24456	32815	32704	26312		
29	260	1049	3811	4237	1221		
30	242	351	826	1204	475		
31	50	827	1424	876	195		
32	6037	5786	5418	5240	5181		
33							
34							
35			622	67	42		
36			2438	664	313		
37		45	1247	462	97		
38		87	1842	788	307		
39		383	1611	2580	1001		
40	2587	2694	3317	3513	2929		
41		211	1863	3308	1124		
42		154	987	1773	583		
43		1738	2902	3195	763		
44	798	1480	7019	6335	3033		
45		240	1006	660	128		
46			51	51			
47			93				
48			135				
49			634	83			
50		321	3381	817	203		
51		214	482	339	123		
52		71	314	151			
53		46	341	372	96		
54			141	233	54		
55		49	796	1649	373		
56		45	565	1128	241		
57			705	625	57		
58			207	200			
59		347	356				
60			680	385	54		
61			616	41	41		
62			214				
63		78	127	59			
64							
65		107	213	132	43		
66			131	80	45		
67			153	309	89		
68			78	155			
69			192	223			
70			158	374	43		
71			226	148			
72		229	210	46			
73			393	82			
74			930	117			
75			459				
76		146	3617	533	65		
77		117	511	209	60		
78		65	107	74	41		
79		49	52	141	46		
80							
81			112	88			
82		41	51	58			
83			197	48			
84	52	41	209	118	49		
85			98	43			
86			49				
87							
88							
89							
90							
91		1012	471	213	61		
92		76		47			
93							
94							
95			64				
96			150				
97			48				
98							
99							
100							
101							
102							
103							
104		75	2376	268			
105		64	243	42			
106		251	123				
107			69				
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Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Paint, Hentel 451-C10

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
128							
129			47	46			
130							
131			42				
132		52	44				
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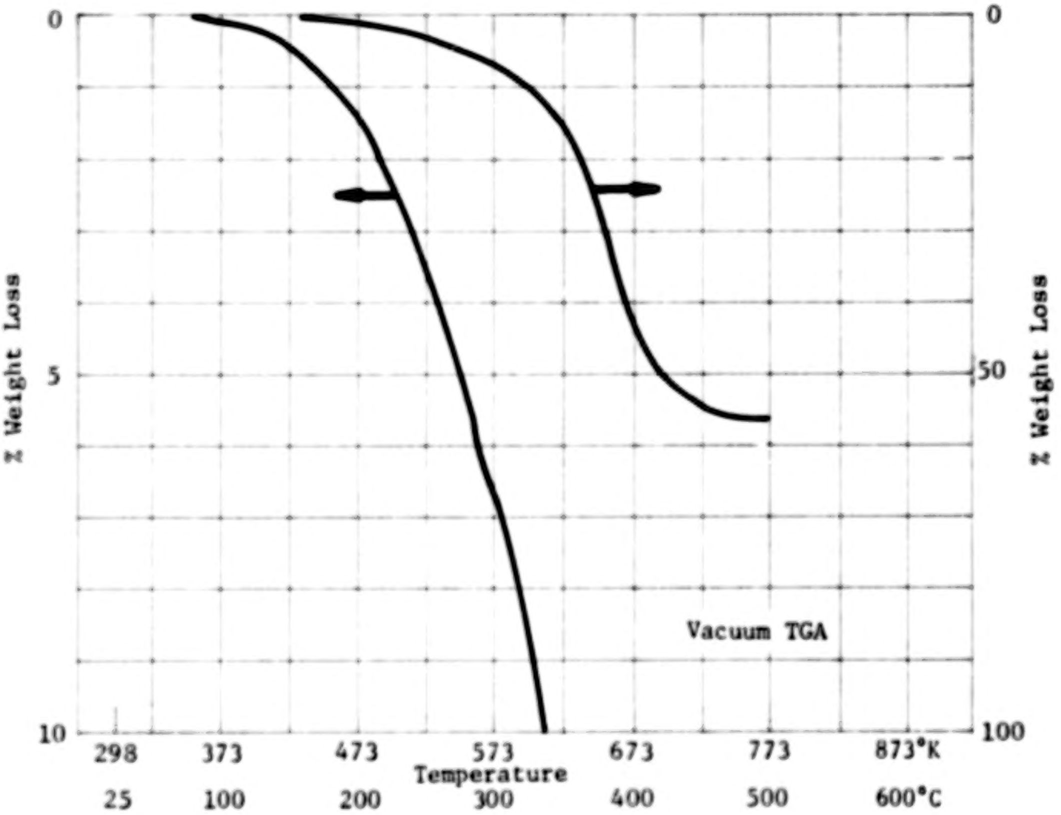
Chemical Characterization Summary

Mix Ratio: **50 pbw resin to 100 pbw activator**
Cure: **1 hr. at 433°K (160°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **548°K (275°C)-723°K (450°C)**

a_o = **50.9%** of initial weight

$$k = 1.24\times10^{26} \exp\left(\frac{-74100}{1.98\ T^\circ K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.0×10^{24}	
373°K (100°C)	1.8×10^{17}	
423°K (150°C)	1.3×10^{12}	

Number and Relative Peak Intensity

Temperature, °K (°C) Scotchcast 241

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	3609	3752	4253	3277	1163		
15	395	718	2686	5155	813		
16	8325	7244	7868	4482	1876		
17	22507	17742	16244	6283	2456		
18	76263	51607	44384	20390	7382		
19	1329	1556	1630	356	138		
20	194	99	111	66			
21							
22							
23							
24		76	407	478			
25		310	2225	2634	116		
26	426	2145	12268	13959	1402		
27	679	2238	11612	19269	2551		
28	31235	36889	47155	35085	8628		
29	508	1450	15387	17134	2591		
30	1540	1789	2780	1708	357		
31		53	979	2762	147		
32	7354	7925	6088	1413	1069		
33							
34							
35							
36			166	420			
37		83	1030	2880	128		
38		213	1391	4879	228		
39	158	1368	8468	17981	1977		
40	3142	3728	5361	6089	1019		
41	71	924	12420	14280	2579		
42	75	499	4513	7365	834		
43	131	636	10429	15315	2066		
44	1442	2600	9763	14741	1165		
45	51	80	1408	2679	250		
46				94			
47			40	165			
48							
49			220	647			
50		308	1394	3128	203		
51	4	315	1470	3242	338		
52		131	956	1358	84		
53		120	3131	3704	429		
54		97	4328	1334	83		
55		382	7605	8698	999		
56		98	2111	7277	186		
57		79	3538	4777	480		
58		47	2816	3085	259		
59			542	1323	57		
60			44	281			
61			74	575			
62		47	101	1211			
63		92	434	2281	116		
64			85	674			
65		127	1329	5649	345		
66		48	415	6880	140		
67		62	3433	3304	322		
68			607	1166			
69			5144	3245	371		
70			1400	1391			
71			580	728	50		
72			233	230			
73			54	292			
74			73	636			
75				260			
76		153	67	234			
77		205	2371	2624	81		
78		72	676	885	96		
79		86	2098	2325	402		
80			236	359			
81			2963	1933	279		
82			897	635	116		
83			2101	1248			
84			904	605			
85			200	334			
86			41				
87			260	430			
88							
89			73	263			
90		75		101			
91		118	2059	2481	491		
92			147	318			
93			989	1268	87		
94		54	288	11093	297		
95			2041	2191	213		
96			687	596			
97			862	436	65		
98			592	222			
99							
100							
101			72	61			
102			48	56			
103			97	274			
104							
105			412	510	97		
106			55	75			
107			515	1279	226		
108			106	464			
109			1075	746	109		
110			206	179			
111			149	70			
112			100	61			
113							
114							
115			136	304			
116			94	71			
117			66	95			
118				44			
119			66	577			
120				76			
121			129	837	92		
122			40	120			
123			456	296			
124			42				
125			56				
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

Scotchcast 241

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
128			51	46			
129							
130							
131				246			
132				64			
133				145			
134				523			
135				73			
136				126			
137			265	104			
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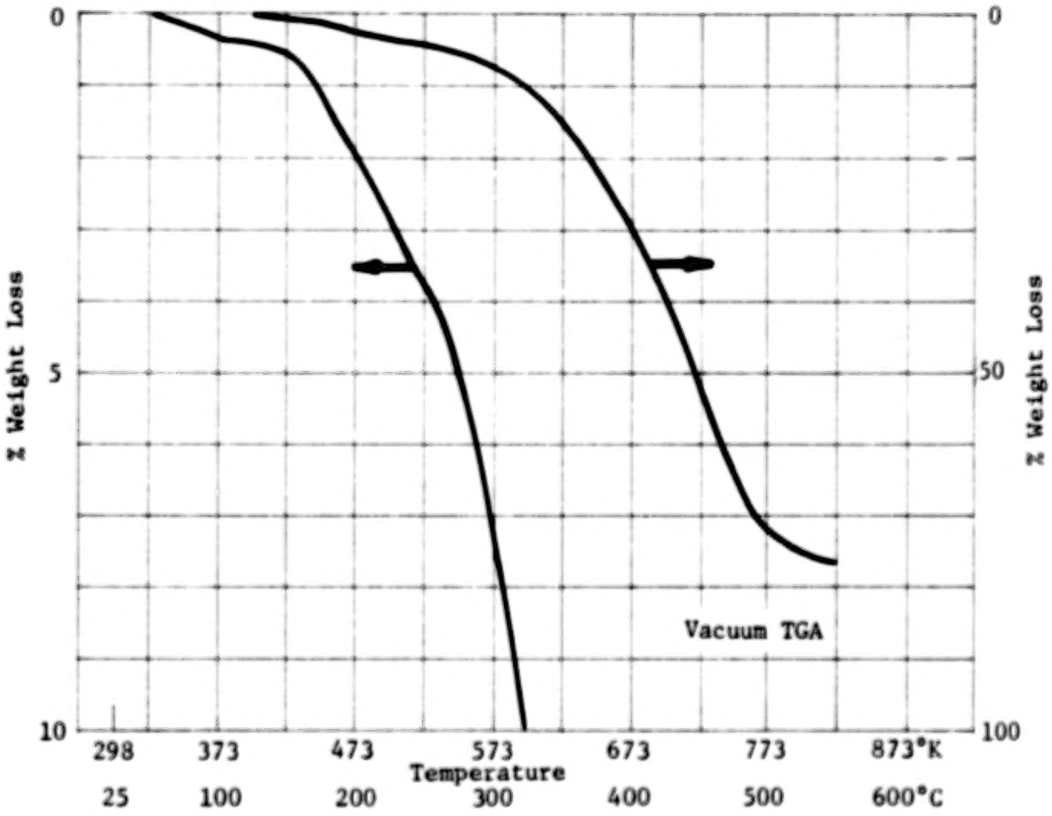
Chemical Characterization Summary

Mix Ratio: **Not applicable**
Cure: **3 hrs. at 414°K (141°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **580°K (307°C)-853°K (580°C)**

a_o = 77% of initial weight

$$k = 7.1\text{x}10^2 \ \exp\left(\frac{-12200}{1.98\ T°K}\right) \ \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	1.6×10^5	
373°K (100°C)	1.3×10^4	
423°K (150°C)	1.8×10^3	

Number and Relative Peak Intensity

Temperature, °K (°C) Scotchcast 583 Tape

m/e							
14							
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24							
25							
26			DATA NOT AVAILABLE				
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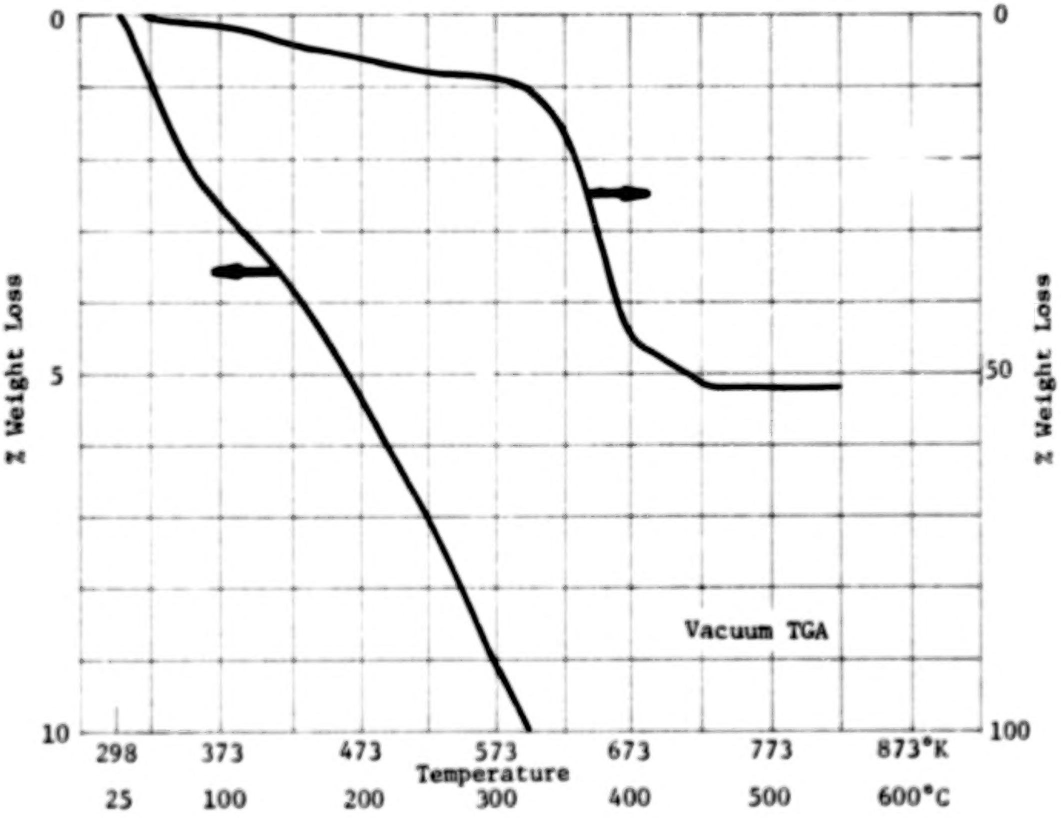
Chemical Characterization Summary

Mix Ratio: **1 pbv resin to 1 pbv activator**
Cure: **Room temperature**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **523°K (250°C)-693°K(420°C)**

a_o = 44.0% of initial weight

$$k = 8.5\times10^{15} \exp\left(\frac{-48200}{1.98\ T^\circ K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	3.8×10^{16}	
373°K (100°C)	1.6×10^{12}	
423°K (150°C)	7.0×10^{8}	

Number and Relative Peak Intensity

Temperature, °K (°C)

Skrapper #423/86

m/e	298 (25)	473 (200)	573 (300)	623 (350)	673 (400)	823 (550)	
14	1467	1626	2627	4875	4114	2004	
15	207	1035	2935	9736	5737	2107	
16	2498	2844	3478	5929	4364	3769	
17		9341	10869	17109	12400	7919	
18	39218	32243	36945	59322	43889	27063	
19				42	73		
20	87	78	121	163	149	77	
21							
22							
23							
24				261	299		
25	130		224			188	
26	133		2081	9062	9092	2153	
27	23861	26307					
28	172	3516	27475	41247	35836	25146	
29	68		3628	11706	8105	1771	
30	40		592	3923	1668	242	
31	5618	4932				223	
32			4829	4905	4926	4497	
33		170			72		
34							
35							
36					147		
37			43			223	
38							
39	1751			7205	16228	2488	
40			2232	5856	6288	2560	
41		3721			4261	886	
42				12612			
43	349	3762	5035	13511	8068	1287	
44		1857	5082	9021	2796	1053	
45		167	1419	6868	944	48	
46				53			
47				154	943		
48					42		
49				129			
50		44	118	1615	4526	457	
51			78	1579	4418	491	
52			69	1186		110	
53			57	1433	2327	125	
54			58			167	
55			506	3288	3808	292	
56		3663	547	3333	1122	160	
57		303	137	1415	1178	72	
58			81	1201	1005		
59					226		
60			424	1910			
61				177		40	
62						111	
63				648	3306	195	
64							
65			69		10840	901	
66			65	3555	10873	923	
67				1007	817		
68				629	230		
69				193	60		
70				284			
71				262			
72				135	44		
73				87	88		
74				129	709		
75					343		
76							
77				453	3457	314	
78				207		84	
79				581	1266	65	
80				180	118		
81				149	40		
82				73			
83				101			
84					40		
85				189	63		
86				43			
87							
88							
89					316		
90					116		
91				273	3335	433	
92				53	294	41	
93					340		
94			91	6890	16169	1288	
95					964		
96				461			
97							
98							
99							
100							
101							
102					54		
103					659		
104				44			
105				52	417	40	
106				43	139		
107				325	2428	161	
108				277	464		
109							
110							
111							
112							
113							
114							
115					184		
116							
117					45		
118				48	128	46	
119				141	2014	176	
120					863		
121				42	3475	59	
122					322		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Skyspar A423/66

m/e	298(25)	473 (200)	573(300)	623 (350)	673 (400)	823 (550)	
128							
129			42	57	87		
130							
131				69	279	72	
132		45	48	61	160	52	
133					360		
134				262	2001	191	
135				73		46	
136				48	722		
137							
138							
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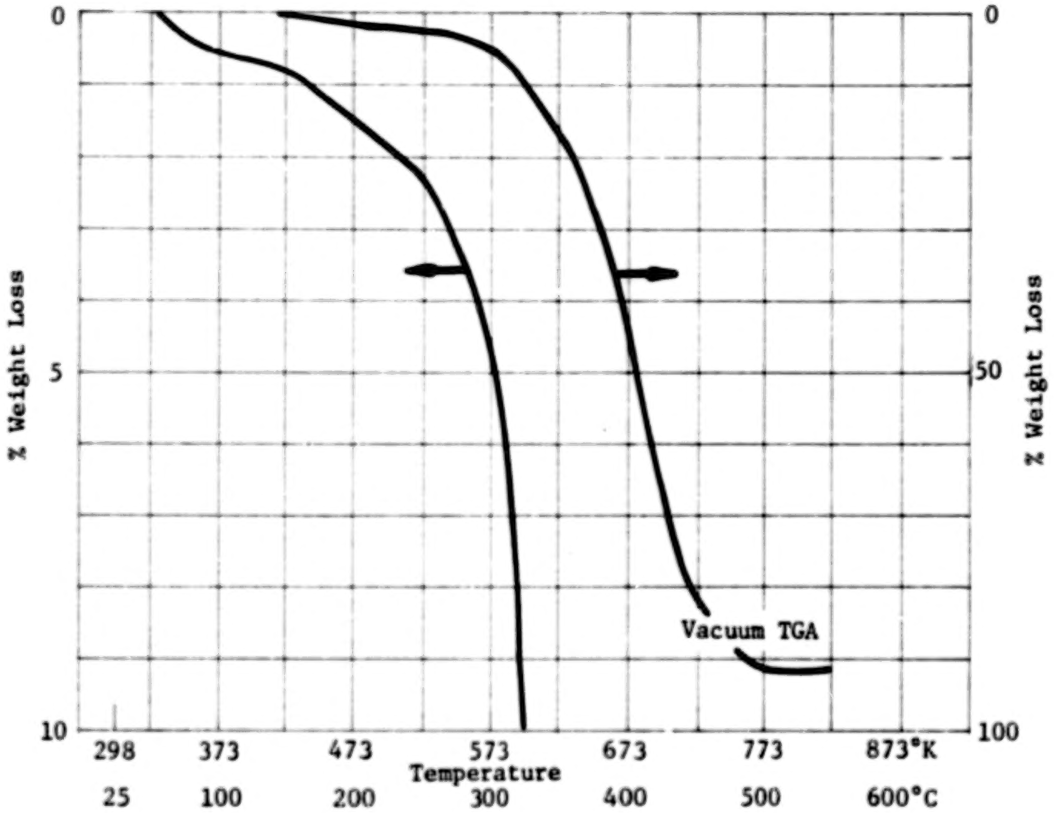
Chemical Characterization Summary

Mix Ratio: **57 pbw Resin to 44 pbw Activator**
Cure: **16 hrs. at 394°K (121°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: 473°K (200°C) - 773°K (500°C)

a_o **=89.6%** of initial weight

$$k = 8.13 \times 10^{6} \exp\left(\frac{-23{,}300}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**5.2 x 10^{8}**	
373°K (100°C)	**3.9 x 10^{6}**	
423°K (150°C)	**9.4 x 10^{4}**	

Number and Relative Peak Intensity

Temperature, °K (°C) SMRD 100F-90

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
14	873	880	872	2338	1269	1064	
15	302	348	352	3038	1547	748	
16	2660	2432	2546	5448	3055	2662	
17	7330	6353	6468	7818	6315	6265	
18	22844	19574	19451	24000	17863	17855	
19	83	98	91	145	80	76	
20	122	112	114	150	137	121	
21							
22				155			
23							
24				200	105	51	
25		44	50	817	335	169	
26	155	209	249	7087	1887	767	
27	318	395	440	15364	4886	1390	
28	7743	7662	7797	33766	11962	10073	
29	151	209	243	6427	3775	768	
30	437	439	460	1018	732	577	
31		50	47	1125	200	133	
32	1977	1912	1837	1695	1752	1955	
33							
34							
35							
36				129	60		
37				1081	305	121	
38			43	2127	565	206	
39	68	141	191	12246	3968	1101	
40	809	848		3421	1797	1259	
41	55	128	159	14340	5589	978	
42		82	83	6565	2278	419	
43	59	125	117	3313	3964	447	
44	555	585	696	20016	1343	948	
45				528	140	74	
46				121			
47							
48				68			
49				410	91	47	
50			46	1902	489	223	
51			53	2296	669	295	
52				1088	326	159	
53			44	2640	863	256	
54				1380	561	161	
55		42	73	21253	2452	512	
56				6921	1630	251	
57				1484	1643	144	
58				189	179		
59							
60				116	80	41	
61				189	63		
62				331	108	57	
63				652	246	124	
64				151	86	42	
65			44	1120	439	205	
66				623	209	110	
67			40	2210	987	276	
68				1855	475	139	
69				3867	940	202	
70				864	716	112	
71				547	564	58	
72				85	92		
73				54	46		
74				115	63		
75				75	47		
76				83	50		
77			49	2122	656	310	
78				711	248	151	
79				2774	787	366	
80				620	201	85	
81				1108	519	135	
82				453	266	65	
83				623	266	53	
84				5004	241	66	
85				378	258		
86				76	68		
87				40			
88							
89				101	54		
90				54			
91			42	2173	807	498	
92				439	153	96	
93				1712	412	197	
94				541	130	66	
95				651	269	78	
96				363	120	44	
97				297	132		
98				156	102		
99							
100					44		
101							
102							
103				71	62		
104				49	44		
105				181	207	71	
106				310	133	96	
107				203	172	46	
108				406	101	60	
109				133	82		
110				76	43		
111				55	41		
112				48			
113							
114							
115					64		
116							
117					55		
118							
119					70		
120							
121				41	57		
122				86	42		
123							
124				201			
125							
126				50			
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C)

SMRD 100F-90

m/e				623 (350)	723 (450)		
128							
129					51		
130							
131							
132							
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142				69			
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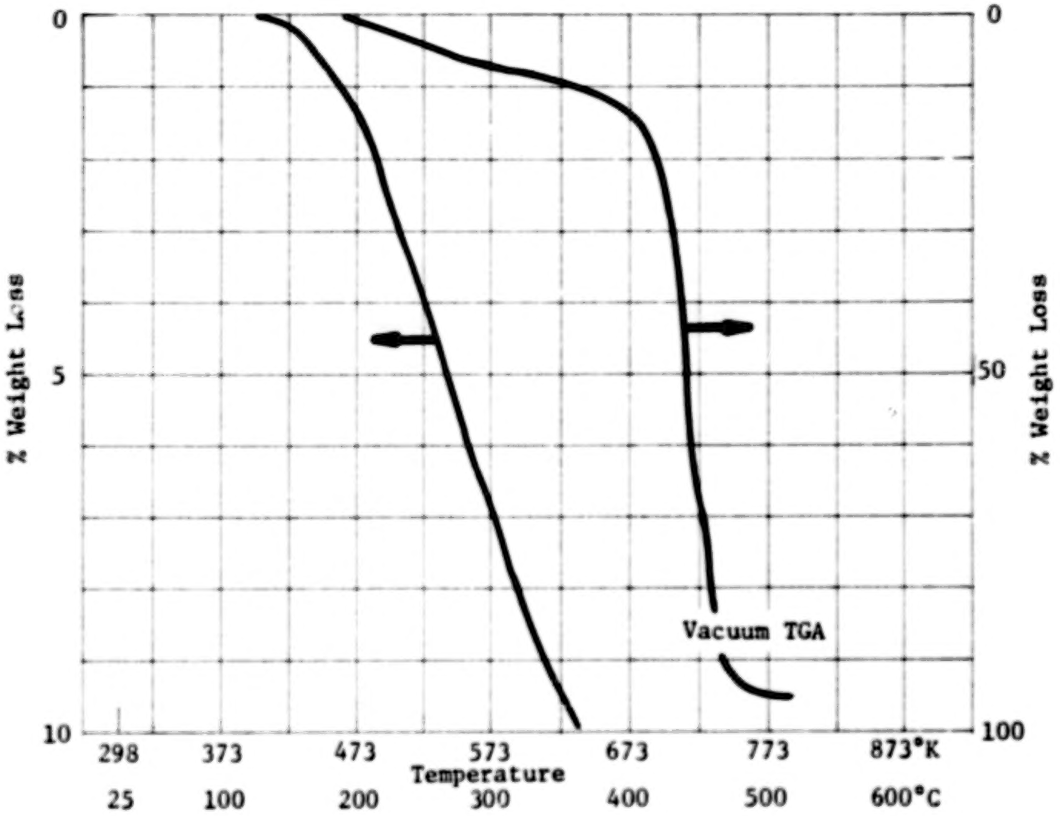
240							

Chemical Characterization Summary

Mix Ratio: **One component**
Cure: **16 hrs. at 496°K (223°C), 16 hrs. at 516°K (243°C)**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **623°K (350°C)- 773°K (500°C)**

a_o = **89.3%** of initial weight

$$k = 1.07\times10^{14} \exp\left(\frac{-48100}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec In Vac	In Nitrogen
323°K (50°C)	2.7×10^{18}	
373°K (100°C)	1.1×10^{14}	
423°K (150°C)	5.0×10^{10}	

Number and Relative Peak Intensity

Temperature, °K (°C) Stycast 960

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
14	345	346	385	631	497		
15		191	174	3485	195		
16	553	508	510	776	856		
17	928	956	956	1032	1371		
18	3069	2567	2734	2985	3728		
19	153	132	139	95	106		
20					41		
21							
22							
23							
24				101			
25				334	61		
26		95	119	2480	285		
27	41	291	294	6764	366		
28	961	1399	1550	5227	2855		
29		147	168	1831	127		
30	66	78	108	156	205		
31							
32	257	265	322	385	527		
33							
34							
35							
36				45			
37				404	42		
38			41	981	58		
39		208	240	6242	354		
40	102	150	186	984	411		
41		192	223	4817	264		
42				455	43		
43				167	41		
44		49	59	135	133		
45							
46							
47							
48							
49				320			
50		58	66	2991	153		
51		106	135	4904	238		
52				1572	78		
53			43	779	43		
54				84	49		
55				317	57		
56				92			
57				573	51		
58				108			
59							
60				233			
61							
62				786			
63		68	69	2546	121		
64		50	58	708	41		
65		57	58	1450	47		
66				203	42		
67				216			
68							
69				48			
70				213			
71				172			
72				241			
73				153			
74				1097	55		
75				1007	44		
76				1134	55		
77		119	127	4680	239		
78		40	64	4097	177		
79		57	51	950	51		
80				62			
81							
82							
83							
84							
85							
86				119			
87				283			
88				97			
89				865	61		
90				182			
91			202	4181	762		
92				467	105		
93				174			
94							
95							
96							
97							
98				138			
99				58			
100							
101		51	51	329			
102		41	69	1826	77		
103		121	51	4279	134		
104		106	118	6565	232		
105		118	100	4085			
106				329			
107							
108							
109							
110							
111							
112							
113				64			
114				87			
115		106	108	3596	230		
116		45	42	1149	82		
117		196	190	8418	235		
118				986	56		
119		84	62	140	43		
120							
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122							
123							
124							
125							
126				161			
127			57	933			

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Stycast 360

m/e	298 (25)	473 (200)	573 (300)	673 (400)	773 (500)		
128		80	60	2321	73		
129				1536	56		
130				1268	72		
131				414	41		
132				373			
133				721			
134				72			
135							
136							
137							
138							
139				68			
140							
141				176			
142				69			
143				251			
144				264			
145		328	312	16616	281		
146			43	1956			
147		94	102	196			
148				115			
149							
150							
151							
152							
153							
154							
155							
156							
157							
158							
159				189			
160		64	56	3477	58		
161				411			
162				44			
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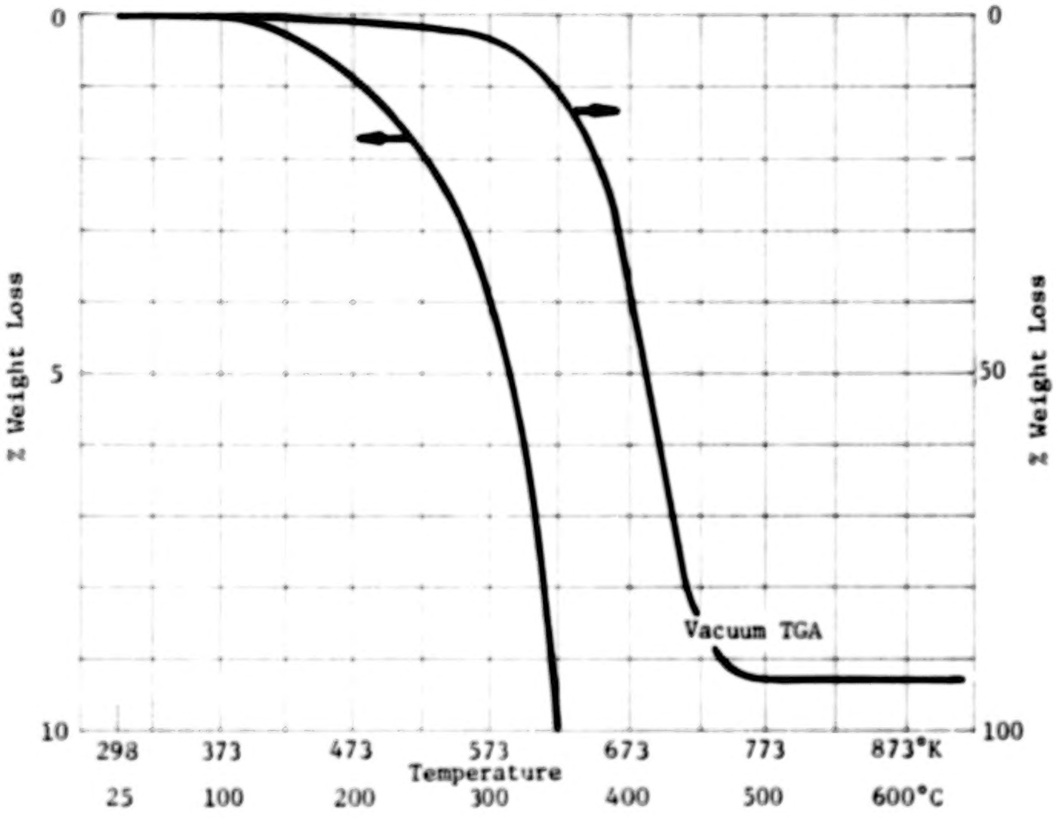
Chemical Characterization Summary

Mix Ratio: **Not Available**
Cure: **Not Available**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **403°K (130°C)-588°K (315°C)**

a_o = **92%** of initial weight

$$k = 1.02 \times 10^{3} \exp\left(\frac{-13700}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	**1.2 x 10^6**	
373°K (100°C)	**6.8 x 10^4**	
423°K (150°C)	**7.4 x 10^3**	

Number and Relative Peak Intensity

Temperature, °K (°C) Shipment 1263/Cat 31

m/e	298 (25)	423 (150)	573 (300)	673 (400)	823 (550)		
14	1503	1447	2360	932	2838		
15	447	769	3318	4062	5967		
16	4831	4370	5115	2122	10627		
17	21815	19500	17753	6175	17366		
18	72785	66025	56333	20787	53319		
19	259	251	182		120		
20	548	500	559		662		
21							
22							
23							
24			545	189	157		
25		187	2276	1435	783		
26	253	1473	13898	11175	4737		
27	662	2626	25642	28598	6963		
28	23601	24746	44973	28614	39369		
29	386	760	8656	9364	2626		
30	1024	1159	1493	556	2214		
31		82	521	497	196		
32	4892	4822	4161	463	4713		
33							
34							
35							
36		50	370	92	191		
37		88	2139	1624	458		
38		221	4358	4704	1071		
39		2265	28706	35638	5519		
40	5329	5967	11684	7988	8298		
41	57	1547	20493	26010	3309		
42	44	181	2546	3093	716		
43	97	218	2644	4959	1145		
44	1283	2251	7772	8876	2947		
45		52	628	997	192		
46			76				
47			239	67	49		
48			78				
49		41	796	632	196		
50		379	4631	5656	1565		
51		488	5535	7467	1937		
52		222	3626	4738	932		
53		542	7315	10482	1320		
54		2651	33346	51355	3640		
55		269	7711	7262	306		
56		42	3770	2265	194		
57			1523	799	140		
58			80	502	55		
59							
60			47				
61			277	195	111		
62			637	580	263		
63		53	1299	1796	672		
64			333	385	161		
65		114	3869	4140	1179		
66		136	4828	4941	836		
67		3367	36062	57650	3668		
68		109	2609	3690	224		
69			886	324	67		
70			593	68			
71			176				
72							
73			94	456	127		
74			338	429	167		
75			131	67	67		
76			131	102	125		
77		146	1903	3267	1517		
78		73	785	1057	575		
79		256	8629	4750	960		
80		92	1244	1672	262		
81		215	3322	4826	326		
82		2429	20572	43120	2962		
83		106	2143	2774	133		
84			239				
85			53				
86							
87					40		
88				147	45		
89					123		
90					118		
91			91	515	1402		
92			44		235		
93					60		
94			3612	2123	596		
95			231				
96							
97			60				
98							
99							
100							
101							
102							
103					87		
104					40		
105			51		345		
106					112		
107			53	299	732		
108			141	326	339		
109							
110			102				
111							
112							
113							
114							
115					40		
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117							
118							
119					40		
120					42		
121				148	148		
122					80		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Stycast 1263/Cat 31

m/e	298 (25)	423 (150)	573 (300)	673 (400)	823 (550)		
128							
129							
130							
131			41		41		
132							
133							
134							
135					41		
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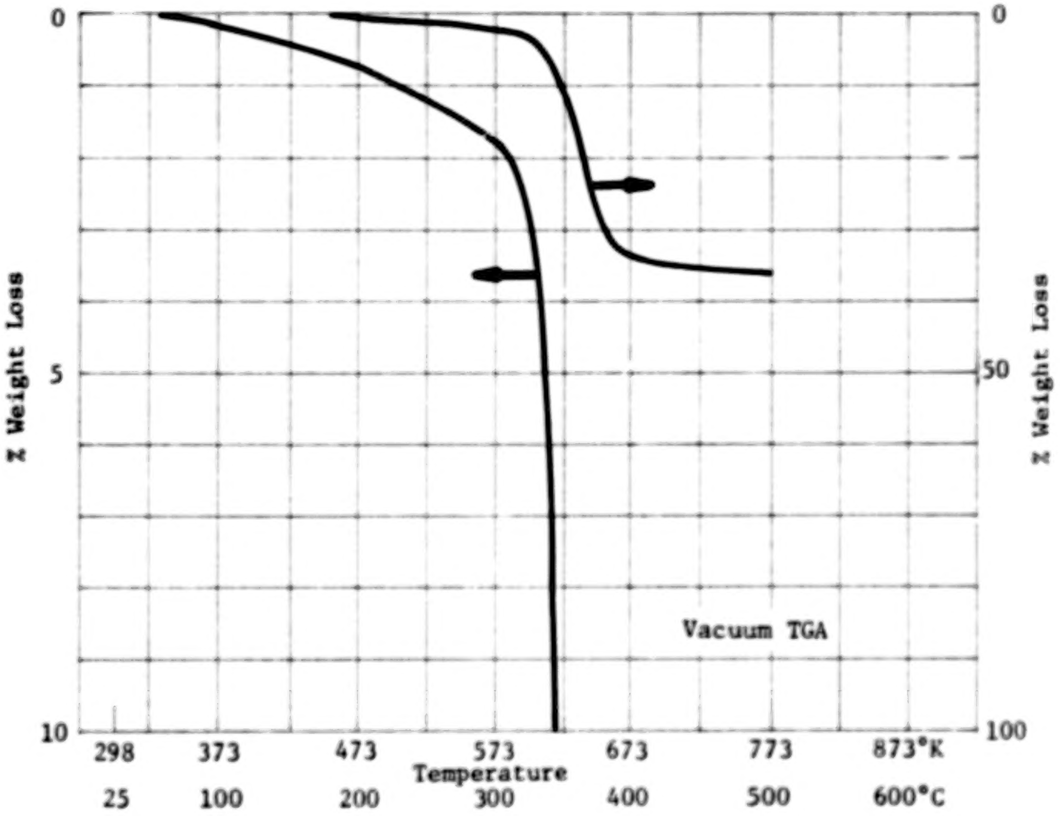
Chemical Characterization Summary

Mix Ratio: **100 pbw resin to 3 pbw catalyst**
Cure: **4 hrs. at room temperature, 4 hrs. at 405°K (132°C)**

1. TGA Preconditioning: **24 hrs. at 23°C (296°K) and 45% of RH**



2. Activation Energy of Decomposition:

Over the Range: **483°K (210°C)-853°K (580°C)**

a_o = **36.0%** of initial weight

$$k = 6.2\times10^{19} \exp\left(\frac{-58100}{1.98\ T°K}\right) \min^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	2.7×10^{19}	
373°K (100°C)	1.4×10^{14}	
423°K (150°C)	1.3×10^{10}	

Number and Relative Peak Intensity

Temperature, °K (°C) [illegible] 2651/Gas 9

m/e	298 (25)	473 (200)	623 (350)	673 (400)	723 (450)		
14	1085	1335	6274	1606	1673		
15	127	476	16052	1623	1447		
16	1886	1970	11416	2632	2801		
17	8272	7066	25835	6910	6076		
18	29751	24126	82060	23228	24271		
19			453				
20			188	40			
21							
22							
23							
24							
25							
26	64	445	25886	3051	1094		
27							
28	19620	20236	52625	22142	21094		
29	100	1893	20746	1738	1262		
30	51		11831	689	421		
31			9333		105		
32	4775	4579	5370	3977	3806		
33							
34							
35							
36							
37					99		
38							
39			45848	5252	2262		
40	801	863	20523	2370	1486		
41		777		1655	1062		
42					720		
43							
44	166	720	24142	2274	1509		
45		46	4918	112			
46							
47			2913	41			
48							
49							
50							
51			13233	2068	783		
52					201		
53			8787	1122	351		
54				179	76		
55		305	10721	862	333		
56			8693	235	96		
57		696		193	47		
58		131	4862		53		
59			1415	40	56		
60				43			
61							
62					70		
63			9697	1216	307		
64					49		
65				2553	698		
66			29700	1996	529		
67				216	59		
68				41	46		
69							
70			999	40			
71			649				
72							
73							
74			2782	138			
75			1519	57	44		
76							
77			9137	2200	760		
78					109		
79			4730	892	250		
80			2873	134	45		
81			1139	43			
82			498				
83			243				
84			251				
85			184				
86			199				
87			276				
88							
89			1757	178			
90					50		
91			10043	2036	601		
92				115			
93				254	41		
94			49375	2594	702		
95			3891	83			
96			307				
97			236				
98			117				
99			68				
100			52				
101			121				
102			373				
103			1857	238			
104			350				
105			1884	186	48		
106				63			
107			7757	[illegible]	663		
108			3001	41	181		
109			[illegible]				
110			[illegible]				
111			99				
112			119				
113			45				
114			61				
115			998	103	41		
116			99				
117			151				
118			1469	80			
119			10505	1695	272		
120			1961	161			
121			6598	1556	608		
122			1802	223	49		
123			62				
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Dataset 2651/Cat. 9

m/e	298 (25)	473 (200)	623 (350)	673 (400)	723 (450)		
128							
129			94	43			
130							
131							
132			620	44	59		
133			349	50	44		
134			2987	325	224		
135			11075	1425	55		
136			1364	229			
137			1442	77			
138			41	185			
139							
140							
141							
142							
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167			59				
168			1234				
169			78	212			
170			3110				
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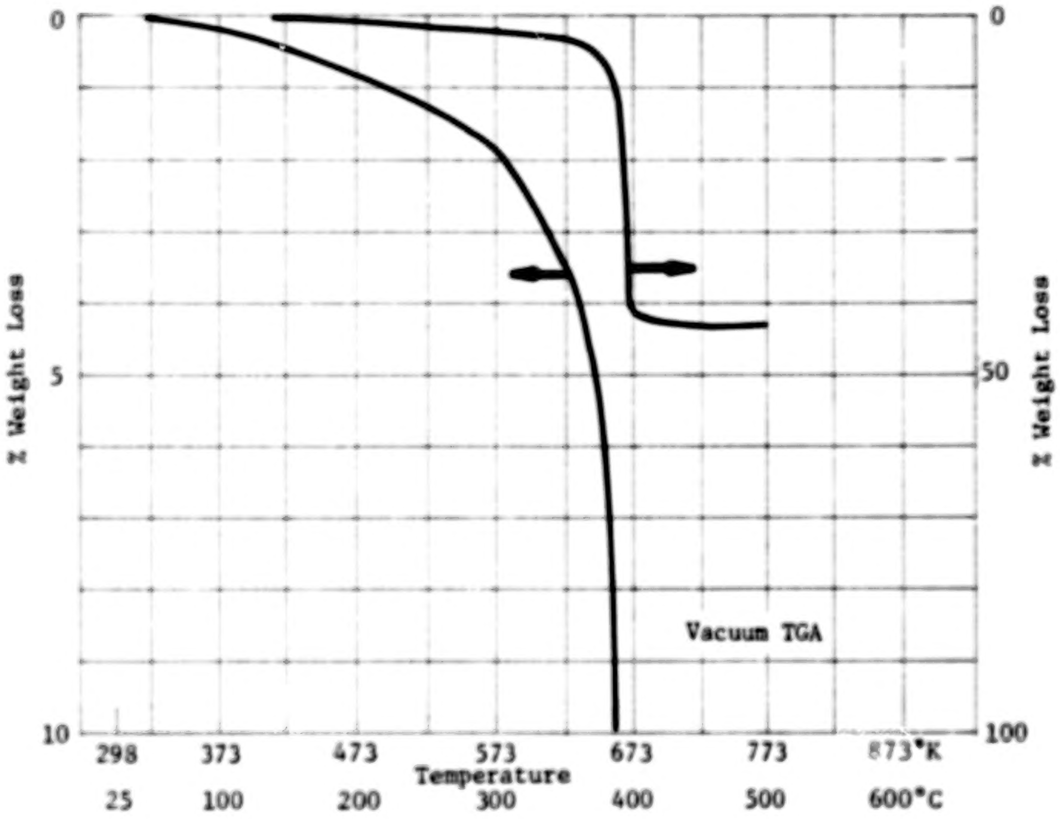
Chemical Characterization Summary

Mix Ratio: 100 pbw resin to 4.5 pbw catalyst
Cure: 4 hrs. at 345°K (74°C), 4 hrs. at 405°K (132°C)

1. TGA Preconditioning: 24 hrs. at 296°K (23°C) and 45% RH



2. Activation Energy of Decomposition:

Over the Range: 593°K (320°C)-853°K (580°C)

a_o = 45.3% of initial weight

$$k = 1.7\times10^{34} \exp\left(\frac{-102920}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	2.5×10^{34}	
373°K (100°C)	3.0×10^{25}	
423°K (150°C)	2.4×10^{18}	

Number and Relative Peak Intensity

Temperature, °K (°C) Stycast 2651/Cat 11

m/e	29[illegible] [illegible]5)	473 (200)	623 (350)	648 (375)	673 (400)		
14	1354	1621	4183	5426	1996		
15	73	567	8012	10685	2076		
16	1429	1536	6653	7712	2741		
17	5142	4955	17794	17636	5995		
18	18[illegible]58	17237	64895	62810	21135		
19			116	305	40		
20			79	96	40		
21							
22							
23							
24			309	955	63		
25							
26	67	781	8512	18646	3912		
27							
28	21554	23549	40747	46925	25609		
29	104	409	16384	16988	2079		
30		116			304		
31		67	5391	5355			
32	5074	4943	5343	5758	4584		
33			193				
34							
35							
36							
37							
38		40					
39			12629	44581	8349		
40	343	598		16751	2891		
41			8323	11133	1924		
42		1758					
43							
44	264	2354	20325	15660	2574		
45			1549	2357	109		
46							
47			766	2933	174		
48				341			
49							
50			3384				
51			2598	13560	3241		
52							
53			1543	7344	1678		
54							
55		50	3362	9407	1382		
56		73	3514	2764	119		
57		85	2808	2126	116		
58		46			76		
59			135		119		
60			149				
61							
62							
63			2491	10637	2364		
64							
65					4512		
66			10406	29063	4082		
67			658				
68			308	994	70		
69			146	131			
70		50	69	82			
71		47	175	171			
72			40				
73							
74			639	2851	384		
75			196	1674	215		
76			73		114		
77			1209	11269	3495		
78			388	4776	904		
79			659		1376		
80			64	639	171		
81			40	401	68		
82				146			
83							
84							
85				45			
86				210			
87			119	214	40		
88			255	40			
89				2050	409		
90			212		445		
91			1136	12014	3035		
92			70		264		
93			93				
94			18512	41060	5425		
95			1119	2729	196		
96				77			
97							
98		589	246	134	43		
99		774	504	108			
100							
101				145			
102			47		67		
103			141	2703	598		
104				467	48		
105			129	2226	400		
106							
107			704	6461	2627		
108			239	2121	942		
109				57			
110							
111							
112							
113							
114							
115			46	1062	237		
116			97	147			
117				417	85		
118			238	1233	62		
119			1061	10766	1962		
120			66	2348	381		
121			1460	10679	3026		
122			85	1539	446		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Stycast 2651/Cat 11

m/e	298 (25)	473 (200)	623 (350)	648 (375)	673 (400)		
128				42			
129			41	65			
130				60			
131			74	576	137		
132			51		67		
133				248	391		
134			1448	2749	1060		
135			61	10279	392		
136				1441	503		
137				2174			
138							
139							
140							
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159							
160							
161							
162			400	965	57		
163			46	532	155		
164			558	903	274		
165			376	75	527		
166				2063	390		
167							
168							
169							
170				50			
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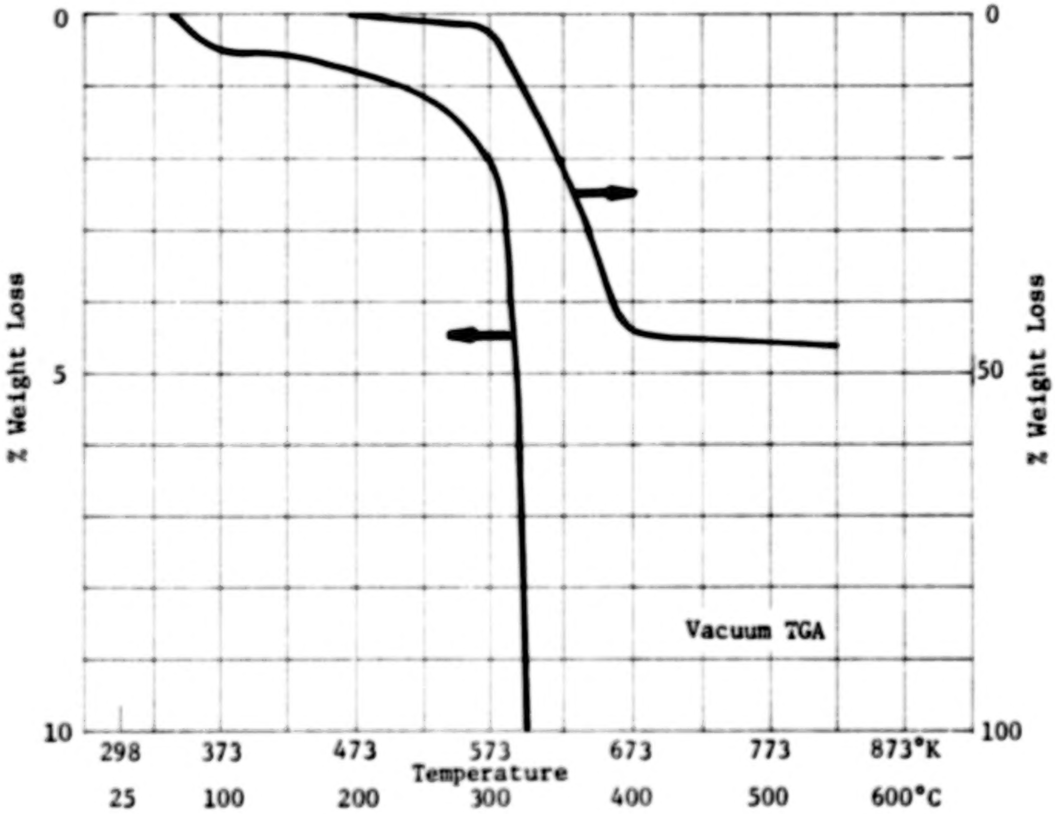
Chemical Characterization Summary

Mix Ratio: **100 pbw Resin (A) to 50 pbw Catalyst (B)**
Cure: **30 minutes at 344°K (71°C),**
24 hrs. at 415°K (142°C) in Vacuum (10^{-3} Torr)

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **473°K (200°C) - 673°K (400°C)**

a_o **=48.0% of initial weight**

$$k = 1.10\times10^{17} \exp\left(\frac{-49{,}900}{1.98\ T^{\circ}K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**4.4×10^{16}**	
373°K (100°C)	**1.3×10^{12}**	
423°K (150°C)	**4.2×10^{8}**	

Number and Relative Peak Intensity

Temperature, °K (°C)

Torr Seal A/B

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
14	1284	1184	1244	4549	1473	1556	
15	495	519	571	11815	1221	1762	
16	2747	2549	3130	11054	2891	3917	
17	9912	8603	8541	25475	7397	9071	
18	33392	28612	25294	74518	22961	29061	
19	223	218	211	462	158	155	
20	234	226	201	395	201	229	
21							
22				48			
23							
24				890	82	75	
25	77	83	88	3040	270	260	
26	369	452	457	15977	1415	1299	
27				18354	1726		
28	14946	14316	14246	44434	16308	16446	
29	259	281	289	9614	896	706	
30	246	255	293	14254	634	519	
31			3092	3420			
32	3532	3199		3323	2972	2968	
33							
34							
35							
36				494	46		
37				3227	177	112	
38			41	6563	347	236	
39				20189	1194	685	
40	1530	1501	1483	11067	1963	1863	
41	71	122	110	7881	709	443	
42	57	85	82	13928	689	404	
43		130	113	7394	547	363	
44	425	564	555	11756	656	614	
45	62	62	62	2299	128	109	
46				364			
47				887			
48				255			
49				1184	75	42	
50	49	66	63	5369	382	246	
51	57	67	66	6470	510	301	
52			48	3580	263	166	
53				4339	301	158	
54				2396	163	86	
55				4529	287	151	
56		64		3928	211	121	
57				1733	109	80	
58				3248	118	72	
59				923			
60				367			
61				1027	46		
62				2061	111	50	
63				4174	271	132	
64				1682	119		
65	48			8048	447	227	
66	44	52	56	9513	363	205	
67				3163	148	70	
68				1351	82	51	
69				887	55		
70				1004	63		
71				640			
72				561			
73				578			
74				1170	71		
75				807	50		
76				652	56		
77				3885	442	218	
78	97	109	98	1645	257	192	
79				2087	220	112	
80				1420	97	53	
81				853	66		
82				586	51		
83				515			
84	80	62	66	441	89	82	
85				350			
86				347			
87				201			
88				78			
89				981	86		
90				569	47	200	
91				4666	356		
92				795	80	50	
93				971	66		
94				15031	446	244	
95				1511	67		
96				338			
97				380			
98				255			
99				145			
100				144			
101				158			
102				255			
103				799	79		
104				254			
105				994	97	77	
106				314			
107				2551	291	176	
108				1553	142	78	
109				392			
110				210			
111				271			
112				211			
113				87			
114				117			
115				508	58		
116				145			
117				288			
118				423			
119				3958	158	57	
120				755	53		
121				1454	179	57	
122				577	64		
123				150			
124				76			
125				55			
126				102			
127				48			

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Torr Seal A/B

m/e	298 (25)	423 (150)	523 (250)	623 (350)	723 (450)	823 (550)	
128				66			
129	80	62	75	149	70	78	
130				46			
131	57	52	52	291	75	65	
132	68	67	60	223	76	67	
133				809	47		
134				3139	126	52	
135				466	42		
136				298			
137				55			
138							
139							
140							
141							
142							
143							
144							
145				52			
146							
147				75			
148				55			
149				49			
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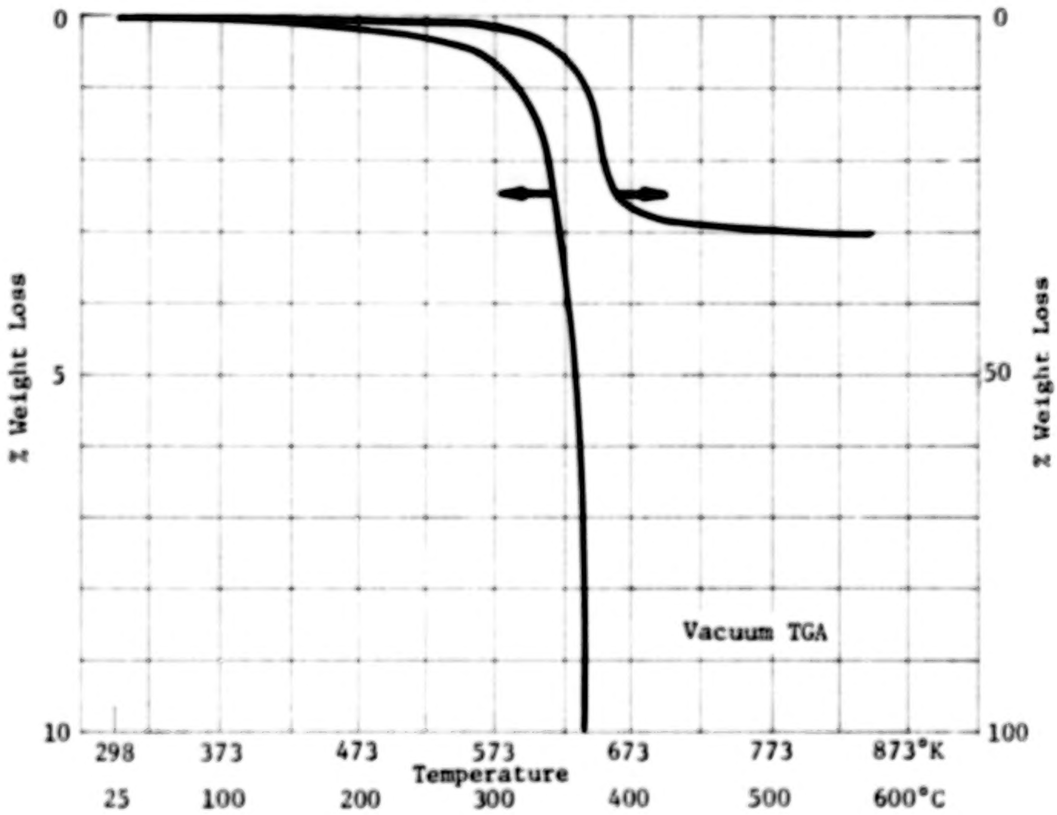
240							

Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 3.4 pbw Catalyst**

Cure: **3 hrs. at 338°K (65°C), 24 hrs. at 414°K (141°C) and 1×10^{-5} Torr**

1. TGA Preconditioning: **None**



2. Activation Energy of Decomposition:

Over the Range: **463°K (190°C)-743°K (470°C)**

a_o = **30%** of initial weight

$$k = 1.6\times10^{15} \exp\left(\frac{-45600}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

Temp	Time, sec	
	In Vac	In Nitrogen
323°K (50°C)	3.7×10^{15}	
373°K (100°C)	2.6×10^{11}	
423°K (150°C)	1.6×10^{8}	

Number and Relative Peak Intensity

Temperature, °K (°C) Tracest [illegible]

m/e	298 (25)	473 (200)	573 (300)	648 (375)	723 (450)		
14	742	679	963	2417	961		
15			323	4655	287		
16	1104	1062	1318	3498	1315		
17	5249	5959	6443	10690	5569		
18	24777	22968	24518	37721	20755		
19				43			
20							
21							
22							
23							
24				176			
25							
26	80	77	838	7814	616		
27		49					
28	12591	14970	17115	28805	15848		
29		46	1152	7412	548		
30			47	2906	66		
31				3067			
32	3636	3504	3313	9472	3240		
33				58			
34							
35							
36				40			
37							
38					43		
39			253	8721	704		
40	116	80	181		330		
41			614	5880	299		
42			199	5981	124		
43				5576	242		
44	250	278	1061	4236	378		
45				929			
46							
47				182			
48							
49							
50				1985	45		
51				2156	63		
52							
53				1425			
54							
55			41		44		
56			321	3148			
57			101	1857			
58				808			
59				70			
60				40			
61				141			
62							
63				1191			
64							
65					99		
66				4163	103		
67				636			
68				241			
69				56			
70				105			
71				112			
72				49			
73				61			
74				182			
75				56			
76				41			
77				1281	74		
78				318			
79				680			
80				428			
81				86			
82							
83							
84							
85							
86							
87							
88							
89			76				
90			92				
91			1162	45			
92			62				
93							
94			6967	190			
95			349	43			
96							
97							
98							
99							
100							
101							
102							
103			81				
104							
105			73				
106							
107			934	45			
108			471				
109							
110							
111							
112							
113							
114							
115							
116							
117							
118							
119			822				
120			63				
121			669				
122			69				
123			67				
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) Truseal 1128/R01

m/e	298 (25)	473 (200)	573 (300)	648 (375)	723 (450)		
128							
129							
130							
131							
132							
133			57				
134			002				
135							
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167			70				
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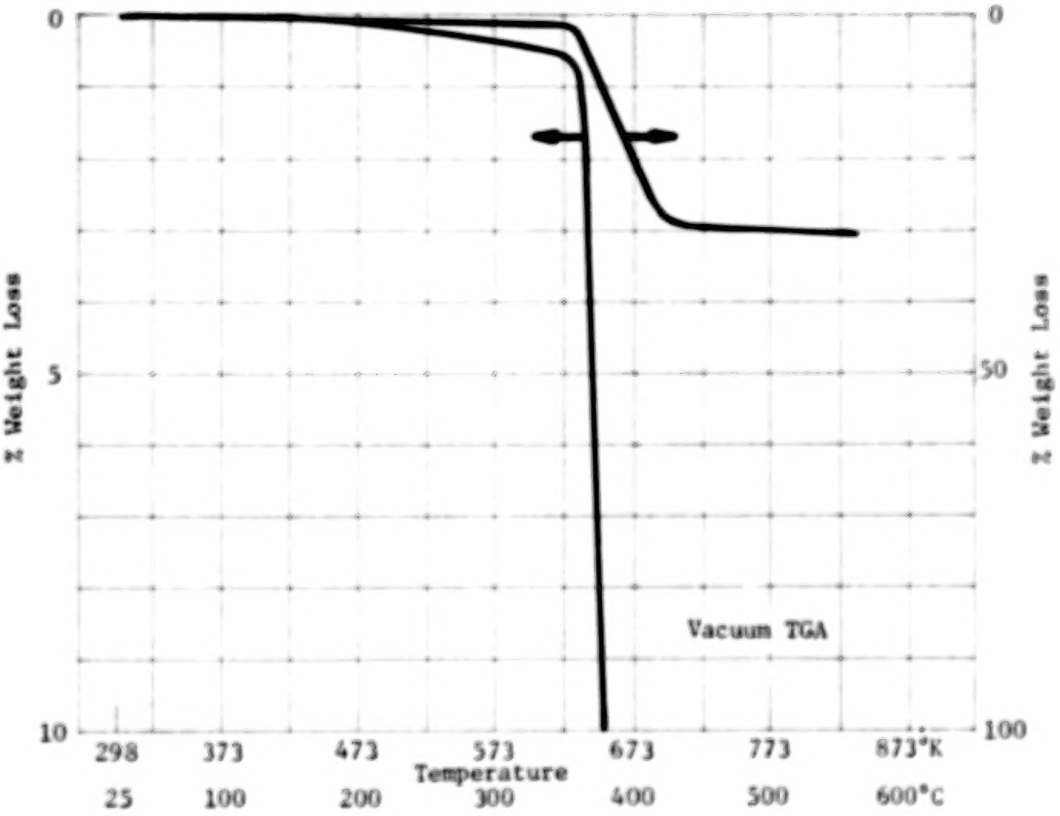
Chemical Characterization Summary

Mix Ratio: **100 pbw Resin to 5 pbw Hardener**
Cure: **3 hrs. at 338°K (65°C), 24 hrs. at 413°K (140°C)**

1. TGA Preconditioning: **24 hrs. at 296°K (23°C) and 45% RH**



2. Activation Energy of Decomposition:

Over the Range: **633°K (360°C)-673°K (400°C)**

a_o = **30%** of initial weight

$$k = 3.4\times10^{28} \exp\left(\frac{-87,600}{1.98\ T°K}\right) \text{min}^{-1}$$

Time to 1% Weight Loss at Temperature T

	Time, sec	
Temp	In Vac	In Nitrogen
323°K (50°C)	**6×10^{30}**	
373°K (100°C)	**6.3×10^{22}**	
423°K (150°C)	**4.4×10^{16}**	

Number and Relative Peak Intensity

Temperature, °K (°C)

[illegible]

m/e	298 (25)	473 (200)	648 (375)	673 (400)	723 (450)	823 (550)	
14	2246	3097	6232	4977	3494	3961	
15	1223	1238	16119	7159	2809	3860	
16	12603	10697	17338	12322	10258	12496	
17	34960	26309	43721	29166	23149	25603	
18	100986	62105	101070	94443	64704	71156	
19	170	367	1086	466	160	140	
20	580	471	600	519	443	520	
21							
22							
23							
24			603	280	77	76	
25	53		2712	1229	385	305	
26	667	566	13572	6414	2192	2020	
27	1536	1506	29124	11581	3705	3640	
28	29390	35034	63032	62624	35700	30553	
29	618	602	43607	12376	2295	1707	
30	3172	2061	5599	4305	3796	3166	
31		77	16711	3059	386	320	
32	11293	9677	6684	6100	8191	9250	
33			1209	108			
34			60				
35							
36			554	240	69		
37			4766	2244	561	140	
38			8826	4476	1036	360	
39	153	179	31772	14507	3759	1413	
40	5957	5340	16810	9105	5737	5030	
41	186	213	33670	8187	1511	1034	
42	97	89	11899	3391	347	467	
43	136	242	24902	5714	1276	730	
44	2946	2767	16627	5260	2786	2953	
45			5193	1313	144	100	
46			433	136			
47			1490	535	66		
48			169	69			
49			1460	726	135	56	
50			6697	3836	992	389	
51			6101	4610	1355	467	
52			1957	1464	483	172	
53			3592	2392	715	168	
54			1021	698	92	59	
55			9115	3190	684	265	
56			15591	2986	304	308	
57			19770	4041	217	119	
58			4068	734	87	46	
59			692	160			
60			563	255			
61			1859	876	173		
62			2935	1596	386	82	
63			5440	3280	933	253	
64			1795	1017	283	70	
65			13018	6866	1622	400	
66			18084	7206	1632	350	
67			1494	710	171	48	
68			786	320	57		
69			385	102			
70			251	60			
71			665	95			
72			829	178			
73			2027	470			
74			1818	872	177	41	
75			775	515	120		
76			606	381	92		
77			3585	3946	1304	373	
78			1315	1320	448	170	
79			1883	1768	628	140	
80			420	250	101		
81			234	162			
82			80	45			
83			43				
84	41		124	63	42		
85			103				
86			142	83			
87			2709	467			
88			142				
89			657	603	170		
90			570	696	119		
91			1206	2378	627	180	
92			342	360	98	85	
93			1586	186	158	81	
94			26147	8608	1715	288	
95			1626	592	100		
96			43				
97							
98							
99							
100							
101							
102			47	110			
103			263	455	146		
104			137	150			
105			224	400	99	68	
106			263	241	42	76	
107			1365	2070	714	191	
108			695	974	329	57	
109			51	48			
110							
111							
112							
113							
114							
115			130	206	87		
116				51			
117			46	93			
118			412	178			
119			359	925	189		
120			317	401	55		
121			989	1509	508	63	
122			129	262	90		
123							
124							
125							
126							
127							

Number and Relative Peak Intensity (Continued)

Temperature, °K (°C) [illegible]

m/e	298 (25)	473 (200)	648 (375)	673 (400)	723 (450)	823 (550)	
128							
129	45	45	77	49	54	56	
130							
131			108	180	63		
132	42		64	72	45	46	
133			57	167			
134			273	673	85		
135			44	135	48		
136			212	202	42		
137							
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16. Abstract

This document contains thermochemical and other properties data on the following types of epoxy materials: adhesives, coatings finishes, inks, electrical insulation, encapsulants, sealants, composite laminates, tapes, and thermal insulators. This document is one of two volumes covering epoxy materials.

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236

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